

Ransom Matthews

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1931 ANNUALOG

A Cumulative Reference of Scientific and
Other Useful Information

EDITED BY

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PREFACE

SINCE the last preface in this series was written four years ago, the edition has grown from a modest beginning to some six thousand copies.

It has been a pleasure and an inspiration to know what importance is placed in these books as references by people of importance, libraries, clubs, et cetera, for the material has been gathered with exceeding care and thoroughly sifted. Each volume represents a year of collecting.

Credit for reproduction has been invariably given at the point of insertion, but there have been several items taken from "Curious Questions" by Sarah H. Killikelly that are of unique interest which would have been cumbersome to note individually. Acknowledgment is herewith made of our obligation to those most interesting and valuable volumes.

Because of the disjointed nature of this work it is difficult to eliminate all errors, but it is believed that a generous criticism will grant the merit of the whole and condone the inadvertence.

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THE YEAR 1931

January

- 1 Thur. New Year's Day
- 6 Tues. Epiphany-Twelfth Day
- 25 Sun. St. Paul's Day

February

- 2 Mon. Candlemas Day
- 12 Thur. Lincoln's Birthday
- 14 Sat. St. Valentine's Day
- 18 Wed. Ash Wednesday
- 22 Sun. Washington's Birthday

March

- 17 Tues. St. Patrick's Day
- 25 Wed. Annunciation (Lady Day)

April

- 1 Wed. All Fool's Day
- 5 Sun. Easter
- 2 Thur. Jewish Pessach (Passover)
- 19 Sun. Patriot's Day (Mass.)
- 23 Thur. St. George's Day
- 25 Sat. St. Mark's Day
- 26 Sun. Southern Memorial Day

May

- 1 Fri. May Day
- 7 Thur. Arbor Day (N. Y.)
- 10 Sun. Mother's Day
- 14 Thur. Ascension Day
- 22 Fri. Shebuoth, Jewish
- 24 Sun. Empire Day (British)
- 24 Sun. Whitsunday-Pentecost
- 28 Wed. Mohammedan New Year
- 30 Sat. Memorial Day

June

- 14 Sun. Children's Day
- 14 Sun. Flag Day
- 24 Wed. St. John Baptist Day
- 29 Mon. St. Peter and Paul Day

July

- 1 Wed. Dominion Day (Canada)
- 3 Fri. Dog Days begin
- 4 Sat. Independence Day
- 15 Wed. St. Swithin's Day

August

- 11 Tues. Dog Days end
- 15 Sat. Assumption Day
- 24 Mon. St. Bartholomew Day

September

- 7 Mon. Labor Day
- 12 Sat. Jewish New Year
- 17 Thur. Constitution Day
- 21 Mon. Yom Kippur
- 23 Tues. Jewish New Year
- 26 Sat. Succoth
- 26 Sat. Indian Day (Utah)
- 29 Tues. Michaelmas-All Angels

October

- 12 Mon. Columbus Day
- 18 Sun. St. Luke's Day
- 27 Tues. Navy Day, Roosevelt's Birth-day
- 31 Sat. Hallowe'en

November

- 1 Sun. All Saints' Day
- 3 Tues. Election Day
- 11 Wed. Armistice Day
- 26 Thur. Thanksgiving Day
- 30 Mon. St. Andrew's Day

December

- 6 Sun. St. Nicholas' Day
- 21 Mon. St. Thomas' Day
- Forefathers Day
- 25 Fri. Christmas Day
- 26 Sat. St. Stephen's Day
- 28 Mon. Holy Innocents
- 31 Thur. New Year's Eve

First
MonthThirty-one
Days

MOON'S PHASES									Sun on Meridian			MOON'S PLACE	CALENDAR for New Eng., N. York, Mich., Wis., Minn., N. and S. Dak., Mont., Wyo., Ida., Wash. and Oregon.						CALENDAR for N. J., Pa., Md., Del., Va., W. Va., Ky., Ind., O., Ill., Mo., Ia., Kans., Neb., Colo., Utah, Nev., and No. Cal.						Moon's South or Meridian Passage				
Eastern Time			Central Time			Civil Time							Sun rises		Sun sets		Moon sets		Sun rises		Sun sets		Moon sets						
D.	H.	M.	D.	H.	M.	D.	H.	M.	S.					H.M.	H.M.	H.M.	H.M.	H.M.	H.M.										
☾	4	8	15M	4	7	15M	1	12	3	27					7	38	4	29	4	38	7	22	4	45	4	21	9	42	
☾	11	12	9M	10	11	9E	11	12	7	51					7	39	4	30	5	53	7	22	4	46	5	32	10	42	
☾	18	1	36E	18	12	36E	21	12	11	1					7	39	4	31	7	6	7	22	4	47	6	43	11	46	
☾	26	7	5E	26	6	5E	28	12	13	0																			
Day									Astronomy, Church Days, etc.																				
1	Th	Circ. New Year's Day						♂	Per.	♂	♂	7	38	4	29	4	38	7	22	4	45	4	21	9	42				
2	Fr	merid. 11 e.-1 m.						♂	♂	♂	♂	7	39	4	30	5	53	7	22	4	46	5	32	10	42				
3	Sa	♂ sets 6-8 eve.						♂	Per.	♂	♂	7	39	4	31	7	6	7	22	4	47	6	43	11	46				
1. 2nd Sunday after Christmas Length of Day 9h 26m—of Twilight 1h 38m																													
4	Su	Orion rises 4-6 mo.						♂	♂	♂	♂	7	38	4	32	rises	7	22	4	48	rises	morn.							
5	M	(6) ♀ Perigee						♂	♂	♂	♂	7	38	4	33	5	39	7	22	4	49	5	59	12	40				
6	Tu	Epiphany						♂	♂	♂	♂	7	38	4	34	6	34	7	22	4	50	7	19	1	51				
7	W	(6th)						♂	♂	♂	♂	7	38	4	35	8	28	7	22	4	50	8	38	2	49				
8	Th	Aries sets 2-4 mo.						♂	♂	♂	♂	7	38	4	36	9	49	7	22	4	51	9	54	3	42				
9	Fr	Arbor Day, La.						♂	♂	♂	♂	7	38	4	37	11	7	7	22	4	52	11	7	4	31				
10	Sa	Capella mer. 9:50 eve.						♂	♂	♂	♂	7	37	4	38	morn.	7	22	4	54	morn.	5		19					
2. 1st Sunday after Epiphany Length of Day 9h 33m—of Twilight 1h 37m																													
11	Su	Leo rises 8-10 eve.						♂	♂	♂	♂	7	37	4	39	12	23	7	22	4	55	12	18	6	6				
12	M	Pleiades mer. 8:15 eve.						♂	♂	♂	♂	7	37	4	40	1	38	7	22	4	56	1	29	6	54				
13	Tu	Hyades mer. 8:50 eve.						♂	♂	♂	♂	7	36	4	42	2	54	7	21	4	57	2	40	7	44				
14	W	Algol (var.) mer. 7:26 eve.						♂	♂	♂	♂	7	36	4	43	4	8	7	21	4	58	3	50	8	36				
15	Th	Gt. Neb. of And. mer. 5 eve.						♂	♂	♂	♂	7	35	4	44	5	20	7	20	4	59	4	58	9	30				
16	Fr	Menkar mer. 7:14 eve.						♂	♂	♂	♂	7	35	4	45	6	24	7	20	5	0	6	1	10	25				
17	Sa	Aldebaran mer. 8:43 eve.						♂	♂	♂	♂	7	34	4	46	7	19	7	20	5	1	6	56	11	20				
3. 2nd Sunday after Epiphany Length of Day 9h 43m—of Twilight 1h 36m																													
18	Su	Hare (Lepus) mer. 9:40 eve.						♂	♂	♂	♂	7	34	4	48	sets	7	19	5	2	sets	ev 11							
19	M	Lee's birthday						♂	♂	♂	♂	7	33	4	49	5	32	7	19	5	3	5	49	1	1				
20	Tu	Orion mer. 9-10 eve.						♂	♂	♂	♂	7	32	4	50	6	39	7	18	5	4	6	52	1	47				
21	W	Kids mer. 9 eve.						♂	♂	♂	♂	7	31	4	52	7	44	7	18	5	6	7	54	2	29				
22	Th	Moon Apogee						♂	♂	♂	♂	7	31	4	53	8	49	7	17	5	7	8	54	3	9				
23	Fr	Mira (var.) mer. 6:3 eve.						♂	♂	♂	♂	7	30	4	55	9	52	7	16	5	8	9	53	3	48				
24	Sa	Cetus (Whale) mer. 4-7 eve.						♂	♂	♂	♂	7	29	4	56	10	54	7	16	5	9	10	57	4	27				
4. 3rd Sunday after Epiphany Length of Day 9h 57m—of Twilight 1h 37m																													
25	Su	♂ n't earth. Child Labor D.						♂	♂	♂	♂	7	28	4	57	11	59	7	15	5	10	11	52	5	7				
26	M	♂ mer. 7 eve. ♂ [Conv. St. Paul						♂	♂	♂	♂	7	27	4	59	morn.	7	14	5	12	morn.	5		50					
27	Tu	Betelgeuse mer. 9 eve.						♂	♂	♂	♂	7	26	5	0	1	6	7	14	5	13	12	55	6	36				
28	W	Pollux mer. 11 eve. ♂ Gr. El. W						♂	♂	♂	♂	7	25	5	2	2	16	7	13	5	14	2	1	7	26				
29	Th	McKinley's birthday						♂	♂	♂	♂	7	24	5	3	3	29	7	12	5	15	3	10	8	23				
30	Fr	Castor mer. 11 eve.						♂	♂	♂	♂	7	23	5	4	4	43	7	11	5	16	4	20	9	24				
31	Sa	Sirius mer. 10 eve.						♂	♂	♂	♂	7	22	5	6	5	51	7	10	5	17	5	27	10	27				

Second
Month



February



Twenty-
eight
Days

MOON'S PHASES						Sun on Meridian		MOON'S PLACE	CALENDAR for			CALENDAR for			Moon's Southing or Meridian Passage		
Eastern Time			Central Time			Civil Time			New Eng., N. York, Mich., Wis., Minn., N. and S. Dak., Mont., Wyo., Ida., Wash. and Oregon.			N. J., Pa., Md., Del., Va., W. Va., Ky., Ind., O., Ill., Mo., Ia., Kans., Neb., Colo., Utah, Nev., and No. Cal.					
D.	H.	M.	D.	H.	M.	D.	H.		M.	S.	Sun	Sun	Moon	Sun		Sun	Moon
											rises	sets	sets	rises		sets	sets
											H.M.	H.M.	H.M.	H.M.		H.M.	H.M.
☾	2	7	26E	2	6	26E	1	12	13	31							
☾	9	11	10M	9	10	10M	11	12	14	22							
☾	17	8	11M	17	7	11M	21	12	13	50							
☾	25	11	42M	25	10	42M	28	12	12	47							
Day	Astronomy, Church					Days, etc.											

5. Septuagesima Sunday Length of Day 10h 10m—of Twilight 1h 38m

1 Su	♂ ♀ b—almost an Oc. or Ecl.	☾ 7 21	5 7	6 49	7 9	5 19	6 15	11 31
2 M	(1) ♀ Gr. El. W, 47° Purif. B.V.M.	☾ 7 20	5 9	rises	7 8	5 20	rises	morn.
3 Tu	☾ Per. (2) ♂ 19' S. of ♀	☾ 7 18	5 10	5 59	7 7	5 21	6 10	12 35
4 W	= sets 7-9 eve.	☾ 7 17	5 12	7 24	7 6	5 22	7 31	1 28
5 Th	☾ mer. 11 eve.-1 mo.	☾ 7 16	5 13	8 47	7 6	5 23	8 49	2 21
6 Fr	Arbor Day, Fla.	☾ 7 15	5 14	10 7	7 4	5 25	10 4	3 12
7 Sa	Orion mer. 8-9 eve.	☾ 7 13	5 16	11 25	7 3	5 26	11 17	4 2

6. Sexagesima Sunday Length of Day 10h 25m—of Twilight 1h 39m

8 Su	Leo rises 6-8 eve.	☾ 7 12	5 17	morn.	7 2	5 27	morn.	4 50
9 M	♂ mer. 7-9 eve.	☾ 7 11	5 19	12 43	7 1	5 28	12 30	5 41
10 Tu	Denebola rises 7:34 eve.	☾ 7 9	5 20	1 59	7 0	5 29	1 42	6 33
11 W	Corvus (crow) rises 10 eve.	☾ 7 8	5 22	3 12	6 59	5 31	2 51	7 27
12 Th	Lincoln's birthday	☾ 7 6	5 23	4 20	6 58	5 32	3 56	8 21
13 Fr	Lyra mer. 9 eve.	☾ 7 5	5 24	5 17	6 56	5 33	4 53	9 16
14 Sa	St. Val's Day ♀ in Aph. ♂ b	☾ 7 4	5 26	6 3	6 55	5 34	5 41	10 8

7. Quinquagesima Sunday Length of Day 10h 41m—of Twilight 1h 25m

15 Su	Capella mer. 7:29 eve.	☾ 7 2	5 27	6 40	6 54	5 35	6 20	10 58
16 M	Regulus mer. 12:17 eve.	☾ 7 1	5 29	7 8	6 53	5 36	6 52	11 44
17 Tu	Shrove Tuesday	☾ 6 59	5 30	sets	6 51	5 38	sets	ev. 27
18 W	Ash Wednesday. Lent begins	☾ 6 57	5 31	6 39	6 50	5 39	6 46	1 8
19 Th	(18) ☾ apogee	☾ 6 56	5 33	7 43	6 49	5 40	7 45	1 47
20 Fr	Castor mer. 9:26 eve.	☾ 6 54	5 34	8 46	6 47	5 41	8 44	2 26
21 Sa	♂ 31' S. of ♀	☾ 6 53	5 36	9 50	6 46	5 42	9 44	3 5

8. Quadragesima Sunday Length of Day 10h 59m—of Twilight 1h 26m

22 Su	Washington's birthday	☾ 6 51	5 37	10 55	6 44	5 43	10 46	3 46
23 M	Pollux mer. 9:26 eve.	☾ 6 49	5 38	morn.	6 43	5 44	11 49	4 30
24 Tu	St. Matthias	☾ 6 48	5 40	12 3	6 42	5 46	morn.	5 18
25 W	Ember Day. ♀ 1° 43' N. of b	☾ 6 46	5 41	1 13	6 40	5 47	12 56	6 10
26 Th	♂ mer. 6-8 mo.	☾ 6 44	5 43	2 25	6 39	5 48	2 3	7 7
27 Fr	Ember Day	☾ 6 43	5 44	3 34	6 37	5 49	3 10	8 8
28 Sa	Ember Day	☾ 6 41	5 45	4 34	6 36	5 50	4 11	9 10

Third
Month

March

Thirty-one
Days

MOON'S PHASES						Sun on Meridian			MOON'S PLACE	CALENDAR for New Eng., N. York, Mich., Wis., Minn., N. and S. Dak., Mont., Wyo., Ida., Wash. and Oregon.			CALENDAR for N. J., Pa., Md., Del., Va., W. Va., Ky., Ind., O., Ill., Mo., Ia., Kans., Neb., Colo., Utah, Nev., and No. Cal.			Moon's Southing or Meridian Passage																	
Eastern Time			Central Time			Civil Time				Sun rises	Sun sets	Moon sets	Sun rises	Sun sets	Moon sets																		
D.	H.	M.	D.	H.	M.	D.	H.	M. S.																									
☾	4	5	36M	4	4	36M	1	12	12	35																							
☾	11	12	15M	10	11	15E	11	12	10	17																							
☾	19	2	51M	19	1	51M	21	12	7	27																							
☾	27	12	4M	26	11	4E	28	12	5	20																							
Day		Astronomy, Church Days, etc.								H.M.	H.M.	H.M.	H.M.	H.M.	H.M.	H.M.																	
9. 2nd Sunday in Lent																	Length of Day 11h 17m—of Twilight 1h 30m																
1	Su	St. David's Day. ♂ 1° S. of ♀										☾	6	39	5	47	5	24	6	34	5	51	5	3	10	11							
2	M	Libra rises 10-12 eve.										M	6	37	5	48	6	3	6	33	5	52	5	47	11	10							
3	Tu	Orion mer. 6-7 eve.										M	6	36	5	49	rises		6	32	5	53	rises		morn.								
4	W	♂ Perigee										☾	6	34	5	51	6	15	6	30	5	55	6	20	12	5							
5	Th	Nov. Crown mer. 5 mo.										☾	6	32	5	52	7	38	6	28	5	56	7	38	12	57							
6	Fr	Canopus mer. 7:30 eve.										☾	6	30	5	53	9	0	6	27	5	57	8	55	1	48							
7	Sa	Regulus mer. 11 eve.										☾	6	28	5	55	10	22	6	25	5	58	10	11	2	39							
10. 3rd Sunday in Lent																	Length of Day 11h 35m—of Twilight 1h 31m																
8	Su	Spica mer. 2:18 mo.										M	6	27	5	56	11	42	6	24	5	59	11	27	3	31							
9	M	♂ mer. 1-3 mo.										♂ Sta.	6	25	5	57	morn.		6	22	6	0	morn.		4	25							
10	Tu	Procyon mer. 8:22 eve.										☾	6	23	5	59	1	0	6	21	6	1	12	40	5	20							
11	W	Sirius mer. 7:25 eve.										☾	6	21	6	0	2	11	6	19	6	2	1	48	6	16							
12	Th	Alphard mer. 10 eve.										☾	6	19	6	1	3	13	6	18	6	3	2	49	7	11							
13	Fr	Sickle mer. 10-11 eve.										♂ ♀	6	18	6	3	4	4	6	16	6	4	3	40	8	4							
14	Sa	Denebola mer. 12:16 mo.										☾	6	16	6	4	4	43	6	14	6	5	4	22	8	55							
11. Mid-Lent Sunday																	Length of Day 11h 53m—of Twilight 1h 32m																
15	Su	Lynx mer. 10 eve.										♂ ♀	6	14	6	5	5	13	6	13	6	6	4	56	9	42							
16	M	♂ mer. 6-8 eve.										♂ Sup. ♂	6	12	6	6	5	37	6	11	6	7	5	24	10	26							
17	Tu	St. Patrick's Day. ♂ Apogee										☾	6	10	6	7	5	56	6	10	6	8	5	47	11	7							
18	W	Arcturus R. 7 eve.										☾	6	8	6	9	6	13	6	8	6	9	6	8	11	47							
19	Th	Orion's Belt sets 11-12 eve.										☾	6	6	6	10	sets		6	6	6	10	sets		ev 26								
20	Fr	Arcturus mer. 2:36 mo.										☾	6	4	6	12	7	42	6	5	6	11	7	37	1	5							
21	Sa	Spring begins										☾	6	3	6	13	8	46	6	3	6	12	8	38	1	45							
12. 5th Sunday in Lent																	Length of Day 12h 12m—of Twilight 1h 32m																
22	Su	Denebola mer. 12 eve.										☾	6	1	6	14	9	54	6	1	6	13	9	42	2	28							
23	M	Hyades sets 11 eve.										☾	5	59	6	16	11	3	6	0	6	14	10	47	3	14							
24	Tu	Aldebaran sets 11:27 eve.										☾	5	57	6	17	morn.		5	58	6	16	11	54	4	4							
25	W	Annunciation (Lady Day)										☾	5	55	6	18	12	14	5	57	6	17	morn.		4	59							
26	Th	Close ♂ of ♀ ♂										☾	5	53	6	19	1	23	5	55	6	18	12	59	5	56							
27	Fr	Castor mer. 7 eve.										♂ ♀	5	51	6	21	2	25	5	53	6	19	2	1	6	56							
28	Sa	♂ 2° S. of ♀										☾	5	50	6	22	3	18	5	52	6	20	2	55	7	56							
13. Palm Sunday																	Length of Day 12h 30m—of Twilight 1h 33m																
29	Su	Pollux mer. 7 eve.										☾	5	48	6	23	3	59	5	50	6	20	3	41	8	53							
30	M	Sirius sets 11 eve.										☾	5	46	6	24	4	32	5	48	6	21	4	18	9	48							
31	Tu	♂ mer. 8-9 eve.										☾	5	44	6	26	4	59	5	47	6	22	4	49	10	41							

Fourth
MonthThirty
Days

MOON'S PHASES						Sun on Meridian		MOON'S PLACE	CALENDAR for New Eng., N. York, Mich., Wis., Minn., N. and S. Dak., Mont., Wyo., Ida., Wash. and Oregon.			CALENDAR for N. J., Pa., Md., Del., Va., W. Va., Ky., Ind., O., Ill., Mo., Ia., Kans., Neb., Colo., Utah, Nev., and No. Cal.			Moon's Southing or Meridian Passage								
Eastern Time			Central Time			Civil Time																	
D.	H.	M.	D.	H.	M.	D.	H.		M.	S.													
☉	2	3	5E	2	2	5E	1		12	4	6												
☾	9	3	15E	9	2	15E	11		12	1	13												
☾	17	8	0E	17	7	0E	21		11	58	49												
☾	25	8	40M	25	7	40M	28		11	57	32												
Day		Astronomy, Church Days, etc.										Sun rises		Sun sets		Moon sets		Eve.					
Day		Astronomy, Church Days, etc.										H.M.		H.M.		H.M.							
1	W	Perigee ♂ in Aph.						M	♈	5	42	6	27	5	21	5	45	6	24	5	17	11	32
2	Th	Total Ecl. ♀ inv. ☐ ♄ ☉, E.							♏	5	40	6	28	rises		5	44	6	25	rises		morn.	
3	Fr	Good Friday							♏	5	38	6	29	7	51	5	42	6	26	7	43	12	24
4	Sa	Pleiades sets 10 eve.							♏	5	36	6	31	9	14	5	40	6	27	9	1	1	15

14. Easter Sunday

Length of Day 12h 49m—of Twilight 1h 34m

5Su	☿ mer. 5-7 eve.	M	☿	5	34	6	32	10	36	5	39	6	28	10	18	2	10
6M	☿ sets 1-2 mo.	☿ ☿ ☉	☿	5	33	6	33	11	54	5	37	6	29	11	32	3	6
7Tu	Regulus mer. 9 eve.		☿	5	31	6	34	morn.		5	36	6	30	morn.		4	4
8W	Libra rises 9-11 eve.		☿	5	29	6	36	1	2	5	34	6	31	12	38	5	2
9Th	☿ sets 1-3 mo.		☿	5	27	6	37	1	59	5	32	6	32	1	35	5	57
10Fr	☿ Gr. Elong. E. 19°	☿ ☿ ☉	☿	5	25	6	38	2	43	5	31	6	33	2	21	6	50
11Sa	☿ mer. 3-5 eve.		☿	5	24	6	40	3	15	5	29	6	34	2	57	7	39

15. Low Sunday

Length of Day 13h 7m—of Twilight 1h 36m

12Su	☿ mer. 7-9 eve.		☿	5	22	6	41	3	42	5	28	6	35	3	27	8	24
13M	Jefferson's birthday ☐ ☿ ☉W		☿	5	20	6	42	4	3	5	26	6	36	3	52	9	6
14Tu	Apogee. Close ☿ ☿.)		☿	5	18	6	43	4	20	5	25	6	37	4	14	9	46
15W	Arbor Day, Utah		☿	5	16	6	45	4	36	5	23	6	38	4	33	10	25
16Th	Ell & Yard S. 10-11 E		☿	5	15	6	46	4	52	5	22	6	39	4	52	11	4
17Fr	Arb. D. Col., Mo. & N. J. ☿ ☿ ☉		☿	5	13	6	47	5	8	5	20	6	40	5	12	11	44
18Sa	Par. Ecl. sun. Invis. in U. S.		☿	5	11	6	48	sets		5	19	6	41	sets		ev.	27

16. 2nd Sunday after Easter

Length of Day 13h 25m—of Twilight 1h 36m

19Su	☿ close to ☿ and Sta. in R. A. M		☿	5	10	6	50	8	54	5	17	6	42	8	38	1	12
20M	So. Cross mer. 10 eve.		☿	5	8	6	51	10	5	5	16	6	43	9	46	2	1
21Tu	Arbor Day, Montana		☿	5	6	6	52	11	15	5	14	6	44	10	52	2	54
22W	Procyon sets 1 mo.		☿	5	4	6	53	morn.		5	13	6	45	11	55	3	51
23Th	St. George's Day		☿	5	3	6	55	12	19	5	12	6	46	morn.		4	49
24Fr	☿ sets 5-7 mo.	☿ ☿ ☉	☿	5	1	6	56	1	14	5	10	6	47	12	51	5	48
25Sa	St. Mark's Day. ☿ 2°44'S. of ☉		☿	5	0	6	57	1	58	5	9	6	48	1	38	6	44

17. 3rd Sunday after Easter

Length of Day 13h 42m—of Twilight 1h 38m

26Su	Southern Memorial Day		☿	4	58	6	58	2	33	5	7	6	49	2	17	7	39
27M	☿ in Aphelion ☿ ☿ ☉		☿	4	56	7	0	3	1	5	6	6	50	2	49	8	30
28Tu	Spica mer. 11 eve.		☿	4	55	7	1	3	24	5	5	6	51	3	17	9	20
29W	Perigee		☿	4	53	7	2	3	44	5	3	6	52	3	42	10	10
30Th	☿ ☿ ☉ Superior		☿	4	52	7	5	4	4	5	2	6	53	4	7	11	1



MOON'S PHASES					Sun on Meridian		MOON'S PLACE	CALENDAR for New Eng., N. York, Mich., Wis., Minn., N. and S. Dak., Mont., Wyo., Ida., Wash. and Oregon.			CALENDAR for N. J., Pa., Md., Del., Va., W. Va., Ky., Ind., O., Ill., Mo., Ia., Kans., Neb., Colo., Utah, Nev., and No. Cal.			Moon's Southing or Meridian Passage
Eastern Time		Central Time		Civil Time		Sun rises		Sun sets	Moon sets	Sun rises	Sun sets	Moon sets		
D. H. M.	D. H. M.	D. H. M.	D. H. M.	D. H. M. S.	H. M.								H. M.	
☉	2 12 14M	1 11 14E	1 11 57	6		4 51	7 5	4 26	5 01	6 54	4 33	11 54		
☾	9 7 48M	9 6 48M	11 11 56	16		4 49	7 6	4 50	5 00	6 55	5 2	morn.		
☾	17 10 28M	17 9 28M	21 11 56	24										
☾	24 2 39E	24 1 39E	28 11 57	2										
☾	31 9 33M	31 8 33M	31 11 57	25										
Day		Astronomy, Church Days, etc.										Eve.		
1 Fr	Aldebaran sets 9 eve.				☿ ☐ ○ E.M.	4 51	7 5	4 26	5 01	6 54	4 33	11 54		
2 Sa	☿ sets 10 eve.					4 49	7 6	4 50	5 00	6 55	5 2	morn.		
18. 4th Sunday after Easter													Length of Day 13h 58m—of Twilight 1h 46m	
3 Su	☿ rises 7-9 eve.				☿	4 47	7 7	rises	4 58	6 56	rises	12 49		
4 M	☿ mer. 11 eve.-1 mo.				M	4 46	7 8	10 42	4 57	6 57	10 19	1 47		
5 Tu	Crater mer. 8 eve.				☾	4 44	7 10	11 46	4 56	6 58	11 22	2 47		
6 W	Arcturus mer. 11 eve.				☿	4 43	7 11	morn.	4 55	6 59	morn.	3 45		
7 Th	☿ mer. 7-9 eve.				☿ b)	4 42	7 12	12 37	4 54	7 12	12 14	4 41		
8 Fr	Regulus mer. 7 eve.				☿	4 40	7 13	1 15	4 52	7 12	12 55	5 32		
9 Sa	Alphard mer. 6 eve.				☿	4 39	7 14	1 44	4 51	7 13	1 28	6 19		
19. Rogation Sunday													Length of Day 14h 14m—of Twilight 1h 48m	
10 Su	Mothers' Day. Close ☿ ♀ ☿ M				☿	4 38	7 16	2 7	4 50	7 14	1 55	7 3		
11 M	☾ Apogee				☿	4 36	7 17	2 26	4 49	7 15	2 17	7 44		
12 Tu	Cancer sets 12 eve.-1 mo.				☿	4 35	7 18	2 42	4 48	7 16	2 38	8 23		
13 W	Southern Cross mer. 8-9 eve.				☾	4 34	7 19	2 58	4 47	7 17	2 58	9 2		
14 Th	Ascension (Holy) Thr.				☾	4 33	7 20	3 14	4 46	7 18	3 17	9 42		
15 Fr	♀ 2° 51' S. of ☾				☿	4 32	7 22	3 30	4 45	7 19	3 37	10 28		
16 Sa	☿ mer. 12 eve. -2 mo.				☿ ☿	4 30	7 23	3 49	4 44	7 10	4 0	11 8		
20. Sunday after Ascension													Length of Day 14h 26m—of Twilight 1h 50m	
17 Su	Virgo mer. 8-10 eve.				☿	4 29	7 24	4 12	4 43	7 10	4 28	11 56		
18 M	Denebola mer. 8 eve.				☿	4 28	7 25	sets	4 42	7 11	sets	ev 49		
19 Tu	Crow mer. 9 eve.				☿	4 27	7 26	10 12	4 42	7 12	9 48	1 45		
20 W	Leo sets 1-3 mo.				☾	4 26	7 27	11 10	4 41	7 13	10 47	2 44		
21 Th	Regulus sets 1 mo.				☿ 2)	4 25	7 28	11 58	4 40	7 14	11 37	3 43		
22 F	Aquila sets 8-10 eve.				☿	4 24	7 29	morn.	4 39	7 15	morn.	4 40		
23 Sa	☿ 2° 41' S. of ☾				☿	4 23	7 30	12 35	4 38	7 16	12 18	5 34		
21. Whit Sunday (Pentecost)													Length of Day 14h 39m—of Twilight 1h 54m	
24 Su	Spica mer. 9 eve.				☿ ☿ M	4 22	7 31	1 4	4 38	7 17	12 52	6 26		
25 M	Lyra mer. 2 mo.				☐ ☿ ☐	4 22	7 32	1 28	4 37	7 17	1 20	7 15		
26 Tu	Arcturus mer. 10 eve.				☿	4 21	7 33	1 49	4 37	7 18	1 45	8 3		
27 W	Ember D.) Perigee. ☿ Gr. El. W				☿	4 20	7 34	2 8	4 36	7 19	2 9	8 51		
28 Th	Libra mer. 10-12 eve.				☿	4 19	7 35	2 28	4 35	7 20	2 34	9 42		
29 Fr	Ember Day. ☿ mer. 4 mo.				☿	4 19	7 36	2 50	4 35	7 20	3 0	10 35		
30 Sa	Ember Day. ☿ rises 8 eve.				☿	4 18	7 37	3 17	4 34	7 21	3 31	11 31		
22. Trinity Sunday													Length of Day 14h 47m—of Twilight 1h 56m	
31 Su	☿ sets 9:30-11:30 eve.				M ☿	4 17	7 38	rises	4 34	7 21	rises	morn.		

Sixth
Month



Thirty
Days

MOON'S PHASES						Sun on Meridian Civil Time		MOON'S PLACE	CALENDAR for New Eng., N. York, Mich., Wis., Minn., N. and S. Dak., Mont., Wyo., Ida., Wash. and Oregon.			CALENDAR for N. J., Pa., Md., Del., Va., W. Va., Ky., Ind., O., Ill., Mo., Ia., Kans., Neb., Colo., Utah, Nev., and No. Cal.			Moon's Position or Meridian Passage																
Eastern Time			Central Time				Sun rises		Sun sets	Moon rises	Sun rises	Sun sets	Moon rises																		
D.	H.	M.	D.	H.	M.	D.								H.		M.	S.														
☾	8	1	18M	8	12	18M	1	11	57	33																					
☉	15	10	2E	15	9	2E	11	11	59	19																					
☽	22	7	23E	22	6	23E	21	12	1	27																					
☾	29	7	47E	29	6	47E	28	12	2	56																					
Day	Astronomy, Church Days, etc.						H.M.	H.M.	H.M.	H.M.	H.M.	H.M.	H.M.																		
1M	Cygnus mer. 2-4 mo.						☿	4 17	7 39	9 29	4 33	7 22	9 5	12 30																	
2Tu	Castor rises 6:35 mo.						☿	4 16	7 40	10 26	4 33	7 23	10 3	1 30																	
3W	Jeff Davis' birthday						♊	4 16	7 40	11 10	4 32	7 24	10 49	2 28																	
4Th	Corpus Christi						♊	4 15	7 41	11 44	4 32	7 24	11 26	3 22																	
5Fr	Southern Cross mer. 7-9 eve.						♊	4 15	7 42	morn.	4 32	7 25	11 56	4 12																	
6Sa	Deneb rises 5:42 eve.						♊	4 14	7 43	12 9	4 32	7 26	morn.	4 57																	
23. 1st Sunday after Trinity																Length of Day 14h 55m—of Twilight 1h 58m															
7Su	Leo sets 12 eve.-2 mo.						☿	4 14	7 43	12 30	4 31	7 26	12 20	5 39																	
8M	☾ Apogee						☿	4 14	7 44	12 48	4 31	7 27	12 42	6 19																	
9Tu	♄ rises 10-12 eve.						☿	4 13	7 45	1 3	4 31	7 27	1 1	6 58																	
10W	♄ astor sets 10 eve.						♊	4 13	7 45	1 19	4 31	7 28	1 20	7 37																	
11Th	St Barnebas						♊	4 13	7 46	1 35	4 30	7 28	1 40	8 18																	
12Fr	♊ mer. 11 eve.-1 mo.						♊	4 13	7 46	1 53	4 30	7 29	2 2	9 1																	
13Sa	♊ r'ses 8-10 eve.						♊	4 12	7 47	2 14	4 30	7 29	2 28	9 48																	
24. 2nd Sunday after Trinity																Length of Day 15h 0m—of Twilight 2h 0m															
14Su	Flag Day						♊	4 12	7 47	2 41	4 30	7 30	2 58	10 39																	
15M	Antares mer. 10:50 eve.						♊	4 12	7 48	sets	4 30	7 30	sets	11 35																	
16Tu	♂ 28' N. of ♄						♊	4 12	7 48	9 2	4 30	7 31	8 38	ev 34																	
17W	Hercules mer. 11 eve.						♊	4 12	7 49	9 54	4 30	7 31	9 32	1 35																	
18Th	Spica mer 7:30 eve.						♊	4 12	7 49	10 35	4 30	7 31	10 17	2 34																	
19Fr	Nor. Crown mer. 10 eve.						♊	4 12	7 50	11 8	4 30	7 32	10 53	3 30																	
20Sa	♄ rises 9-11 eve.						♊	4 13	7 50	11 33	4 31	7 32	11 23	4 23																	
25. 3rd Sunday after Trinity																Length of Day 15h 1m—of Twilight 2h 1m															
21Su	☾ Perigee—♂ close to ☾						♊	4 13	7 50	11 54	4 31	7 32	11 50	5 12																	
22M	Summer begins						♊	4 13	7 50	morn.	4 31	7 32	morn.	6 0																	
23Tu	Sickle sets 11 eve.						♊	4 13	7 50	12 14	4 31	7 32	12 14	6 48																	
24W	Nativity John the Baptist						♊	4 14	7 51	12 33	4 32	7 33	12 38	7 36																	
25Th	♄ rises 11 eve.-1 mo.						♊	4 14	7 51	12 54	4 32	7 33	1 3	8 27																	
26Fr	♄ rises 10-12 eve.						♊	4 14	7 51	1 18	4 32	7 33	1 31	9 21																	
27Sa	Algol rises 11:41 eve.						♊	4 15	7 51	1 48	4 33	7 33	2 5	10 18																	
26. 4th Sunday after Trinity																Length of Day 15h 0m—of Twilight 2h 1m															
28Su	Fomalhaut rises 12 eve.						♊	4 15	7 50	2 25	4 33	7 33	2 46	11 17																	
29M	Peter & Paul						♊	4 16	7 50	rises	4 33	7 33	rises	morn.																	
30Tu	♄ mer. 8-10 eve.						♊	4 16	7 50	9 4	4 34	7 33	8 42	12 15																	

Seventh
Month



Thirty-one
Days

MOON'S PHASES					Sun on Meridian		MOON'S PLACE	CALENDAR for New Eng., N. York, Mich., Wis., Minn., N. and S. Dak., Mont., Wyo., Ida., Wash. and Oregon.			CALENDAR for N.J., Pa., Md., Del., Va., W. Va., Ky., Ind., O., Ill., Mo., Ia., Kans., Neb., Colo., Utah, Nev., and No. Cal.			Moon's Position or Meridian Passage	
Eastern Time		Central Time		Civil Time		Sun rises		Sun sets	Moon rises	Sun rises	Sun sets	Moon rises			
D. H. M.	D. H. M.	D. H. M.	D. H. M. S.												
☾	7 6 52E	7 5 52E	1 12 3 32												
☾	15 7 20M	15 6 20M	11 12 5 13												
☾	22 12 16M	21 11 16E	21 12 6 13												
☾	29 7 47M	29 6 47M	28 12 6 21												
Day	Astronomy, Church Days, etc.						H.M.	H.M.	H.M.	H.M.	H.M.	H.M.	H.M.		
1W	Nor. Crown mer.	9 eve.	♂ b)M	☾	4 16	7 50	9 42	4 34	7 33	9 23	1 11				
2Th	Algenib rises	10:38 eve.	M	☾	4 17	7 50	10 10	4 35	7 33	9 55	2 3				
3Fr	Dog days begin			☾	4 18	7 50	10 33	4 35	7 32	10 22	2 50				
4Sa	Independence Day			☾	4 18	7 50	10 51	4 36	7 32	10 44	3 34				
27. 5th Sunday after Trinity														Length of Day 14h 56m—of Twilight 1h 59m	
5Su	Earth farthest from sun	⊕ Aph.	☾	☾	4 19	7 49	11 8	4 36	7 32	11 5	4 15				
6M	☾ Apogee		☾	☾	4 20	7 49	11 23	4 37	7 32	11 24	4 54				
7Tu	☐ of Pegasus rises	9-11 eve.	☾	☾	4 20	7 49	11 39	4 38	7 31	11 43	5 33				
8W	Lyra mer.	11-12 eve.	♂ δ)☾	☾	4 21	7 48	11 56	4 38	7 31	morn.	6 13				
9Th	♂ 1° 29' N. of ☐		☾	☾	4 22	7 48	morn.	4 39	7 31	12 4	6 54				
10Fr	♈ mer.	5-7 eve.	☾	☾	4 22	7 47	12 15	4 40	7 30	12 27	7 39				
11Sa	☾ rises	11 eve.-1 mo.	☾	☾	4 23	7 47	12 39	4 40	7 30	12 55	8 28				
28. 6th Sunday after Trinity														Length of Day 14h 49m—of Twilight 1h 57m	
12Su	So. Cross mer.	5 eve.	☐ δ)☾	☾	4 24	7 46	1 10	4 41	7 30	1 30	9 21				
13M	♈ mer.	9-11 eve.	☐ δ)☾	☾	4 25	7 46	1 52	4 42	7 29	2 15	10 20				
14Tu	☾ sets	9-11 eve.	♂ ♀)☾	☾	4 26	7 45	2 47	4 42	7 29	3 10	11 21				
15W	St. Swithin's Day		♂ ☐)☾	☾	4 27	7 44	sets	4 43	7 28	sets	ev. 22				
16Th	☾ rises	2-4 mo.	♂ ♀)☾	☾	4 28	7 44	9 7	4 44	7 28	8 51	1 20				
17Fr	Betelgeuse rises	4 mo.	☾	☾	4 28	7 43	9 35	4 44	7 27	9 24	2 16				
18Sa	☐ Perigee		☾	☾	4 29	7 42	9 59	4 45	7 26	9 52	3 8				
29. 7th Sunday after Trinity														Length of Day 14h 40m—of Twilight 1h 54m	
19Su	♂ 50' S. of ☐		☾	☾	4 30	7 41	10 19	4 46	7 26	10 18	3 57				
20M	Altair mer.	12 eve.	☾	☾	4 31	7 40	10 39	4 47	7 25	10 42	4 46				
21Tu	Orion rises	3-4 mo.	☾	☾	4 32	7 39	10 59	4 48	7 24	11 7	5 34				
22W	Mary Magdalen		☾	☾	4 33	7 38	11 22	4 49	7 23	11 34	6 24				
23Th	7 Stars rises	12:30 mo.	☾	☾	4 34	7 38	11 49	4 49	7 23	morn.	7 16				
24Fr	Aldebaran rises	1 mo.	☾	☾	4 36	7 36	morn.	4 50	7 22	12 5	8 12				
25Sa	St. James		♂ ☐)☾	☾	4 37	7 36	12 23	4 51	7 21	12 44	9 9				
30. 8th Sunday after Trinity														Length of Day 14h 28m—of Twilight 1h 53m	
26Su	Aquila mer.	11:30 eve.	☾	☾	4 38	7 34	1 7	4 52	7 20	1 30	10 7				
27M	Rigel rises	3:20 mo.	☾	☾	4 39	7 33	2 2	4 53	7 19	2 26	11 3				
28Tu	☾ mer.	10-12 eve.	♂ b)☾	☾	4 40	7 32	3 5	4 54	7 18	3 28	11 55				
29W	Vega mer.	10 eve.	☾	☾	4 41	7 31	rises	4 55	7 17	rises	morn.				
30Th	Milkmaid's Dipper sets	2-3 mo.	☾	☾	4 42	7 30	8 36	4 56	7 16	8 24	12 44				
31Fr	Milkmaid's Dio. mer.	9-10 eve.	☾	☾	4 43	7 29	8 56	4 56	7 15	8 47	1 29				

Eighth
Month



August



Thirty-one
Days

MOON'S PHASES					Sun on Meridian		MOON'S PLACE	CALENDAR for New Eng., N. York, Mich., Wis., Minn., N. and S. Dak., Mont., Wyo., Ida., Wash. and Oregon.			CALENDAR for N. J., Pa., Md., Del., Va., W. Va., Ky., Ind., O., Ill., Mo., Ia., Kans., Neb., Colo., Utah, Nev., and No. Cal.			Moon's Southing or Meridian Passage
Eastern Time		Central Time		Civil Time		Sun		Sun	Moon	Sun	Sun	Moon		
D.	H. M.	D.	H. M.	D.	H. M. S.	rises		sets	rises	rises	sets	rises		
☾	6 11 28M	6 10 28M	1 12 6 13	11 12 5 11	21 12 3 12	H.M.		H.M.	H.M.	H.M.	H.M.	H.M.	morn.	
☾	13 3 27E	13 2 27E	11 12 5 11	21 12 3 12	28 12 1 20	4 44	7 27	9 13	4 57	7 14	9 8	2 11		
☾	20 6 36M	20 5 36M	21 12 3 12	28 12 1 20	31 12 0 27									
☾	27 10 9E	27 9 9E	31 12 0 27											
Day	Astronomy, Church Days, etc.													
1 Sa	☾ rises 2-4 mo.													
31. 9th Sunday after Trinity						Length of Day 14h 15m—of Twilight 1h 50m								
2 Su	☾ sets 12 eve.-2 mo.					☾	4 46	7 26	9 28	4 58	7 13	9 28	2 51	
3 M	☾ Apogee					☾	4 47	7 25	9 44	4 59	7 12	9 46	3 30	
4 Tu	☾ sets 2-4 mo. ☾ δ 2° S. of ☾					☾	4 48	7 24	10 0	5 0	7 11	10 6	4 9	
5 W	Antares mer. 7 eve.					☾	4 49	7 22	10 18	5 1	7 10	10 28	4 49	
6 Th	Transfiguration ☽ 25' N. of ☾					☾	4 50	7 21	10 39	5 2	7 9	10 54	5 32	
7 Fr	Name of Jesus M					☾	4 51	7 19	11 6	5 3	7 8	11 25	6 18	
8 Sa	☽ Gr't Elong. E. of ☾—27° M					☾	4 52	7 18	11 42	5 4	7 6	morn.	7 9	
32. 10th Sunday after Trinity						Length of Day 14h 0m—of Twilight 1h 45m								
9 Su	Denebola sets 9 eve. M					☾	4 54	7 16	morn.	5 5	7 5	12 4	8 4	
10 M	Harp mer. 9 eve. ☾					☾	4 55	7 15	12 30	5 6	7 4	12 54	9 3	
11 Tu	Altair mer. 10:27 eve. M					☾	4 56	7 14	1 32	5 7	7 3	1 55	10 4	
12 W	Spica sets 9:21 eve. ☽ ☾					☾	4 57	7 12	2 46	5 8	7 2	3 7	11 4	
13 Th	Corvus sets 7-8 eve. ☽ ☽					☾	4 58	7 10	sets	5 9	7 0	sets	ev 2	
14 Fr	Job's Coffin mer. 11 eve. ☾					☾	5 0	7 9	8 0	5 10	6 59	7 52	12 57	
15 Sa	Assumption B.V.M. ☽ Perigee					☾	5 1	7 7	8 22	5 11	6 58	8 19	1 49	
33. 11th Sunday after Trinity						Length of Day 13h 44m—of Twilight 1h 38m								
16 Su	Menkar rises 11 eve. ☽					☽	5 2	7 6	8 43	5 12	6 56	8 44	2 39	
17 M	♂ 41' N. of ☽ ☽					☽	5 3	7 4	9 3	5 12	6 55	9 9	3 29	
18 Tu	☽ rises 9-11 eve. ☽ in Per. ☽					☽	5 4	7 3	9 25	5 13	6 53	9 36	4 20	
19 W	☽ rises 12 eve.-2 mo. ☽					☽	5 6	7 1	9 51	5 14	6 52	10 6	5 12	
20 Th	Deneb. mer. 10:43 eve. ☽					☽	5 7	6 59	10 23	5 15	6 51	10 43	6 2	
21 Fr	Cetus mer. 2-5 mo. ☽					☽	5 8	6 58	11 4	5 16	6 49	11 27	7 2	
22 Sa	Arcturus sets 11:22 eve. ☽					☽	5 9	6 56	11 55	5 17	6 48	morn.	8 1	
34. 12th Sunday after Trinity						Length of Day 13h 28m—of Twilight 1h 38m								
23 Su	☽ sets 9-11 eve. ☽					☽	5 10	6 54	morn.	5 18	6 46	12 20	8 58	
24 M	St. Bartholomew ☽ ☽					☽	5 11	6 52	12 56	5 19	6 45	1 19	9 51	
25 Tu	☽ sets 7-9 eve. ☽					☽	5 13	6 51	2 3	5 20	6 43	2 24	10 41	
26 W	Lyra mer. 8 eve. ☽ Per. ☽					☽	5 14	6 49	3 13	5 21	6 42	3 30	11 26	
27 Th	Algol (var.) rises 7:30 eve. ☽					☽	5 15	6 47	rises	5 22	6 40	rises	morn.	
28 Fr	☽ mer. 11:45 eve.-1:45 mo. ☽					☽	5 16	6 46	7 19	5 23	6 39	7 13	12 9	
29 Sa	John the Bap. beheaded. ☽ ☽					☽	5 17	6 44	7 35	5 24	6 37	7 33	12 50	
35. 13th Sunday after Trinity						Length of Day 13h 11m—of Twilight 1h 34m								
30 Su	Betelgeuse rises 1 mo. ☽					☽	5 18	6 42	7 50	5 25	6 36	7 52	1 29	
31 M	☽ mer. 10-12 eve. ☽ ☽ ☽ ☽ ☽					☽	5 20	6 40	8 6	5 26	6 34	8 11	2 7	

Ninth
Month

September

Thirty
Days

MOON'S PHASES						Sun on Meridian		CALENDAR for New Eng., N. York, Mich., Wis., Minn., N. and S. Dak., Mont., Wyo., Ida., Wash. and Oregon.			CALENDAR for N. J., Pa., Md., Del., Va., W. Va., Ky., Ind., O., Ill., Mo., Ia., Kans., Neb., Colo., Utah, Nev., and No. Cal.			Moon's Southing or Meridian Passage									
Eastern Time			Central Time			Civil Time		MOON'S PLACE							morn.								
D.	H.	M.	D.	H.	M.	D.	H.		M.	S.	Sun rises	Sun sets	Moon rises	Sun rises			Sun sets	Moon rises					
☾	5	2 21M	5	1 21M	1 12 0 8	☾	11		11	56 49	☾	18	3 37E	18			2 37M	21 11 53 17	☾	26	2 45E	26	1 45E
Day	Astronomy, Church Days, etc.											H.M.	H.M.	H.M.	H.M.	H.M.	H.M.	H.M.					
1 Tu	Aldebaran rises 11 eve.											M	☿	5 21	6 38	8 22	5 27	6 33	8 32	2 47			
2 W	☾ rises 3-5 mo.												☿	5 22	6 36	8 42	5 28	6 31	8 56	3 28			
3 Th	☿ rises 11 eve.-1 mo.												☿	5 23	6 35	9 6	5 29	6 29	9 23	4 12			
4 Fr	☿ rises 4-6 mo.											♂ ♀ ♀	☿	5 24	6 33	9 38	5 30	6 28	9 58	5 0			
5 Sa	☿ mer. 3-5 mo.											♂ ♀ ☉, Infr.	☿	5 26	6 31	10 19	5 31	6 26	10 42	5 52			
36. 14th Sunday after Trinity																		Length of Day 12h 52m—of Twilight 1h 34m					
6 Su	Pleiades rises 9:14 ev											☾	☿	5 27	6 29	11 13	5 32	6 24	11 37	6 48			
7 M	Labor Day												☿	5 28	6 27	morn.	5 32	6 23	morn.	7 47			
8 Tu	Nativity of Mary ♂ ♀ ☉ Supr.											☾	☿	5 29	6 25	12 20	5 33	6 21	12 43	8 47			
9 W	☾ sets 9-11 eve.											☾	☿	5 30	6 22	1 38	5 34	6 20	1 57	9 45			
10 Th	Aquila mer. 8-9 eve.											☾	☿	5 32	6 20	3 1	5 35	6 18	3 16	10 41			
11 Fr	Job's Coffin mer. 9 eve.											☾	☿	5 33	6 18	4 26	5 36	6 16	4 35	11 34			
12 Sa	☾ Perigee. ☉ by ☾ Par. Ecl. ☉											☿	☿	5 34	6 16	sets	5 37	6 15	sets	ev. 26			
37. 15th Sunday after Trinity																		Length of Day 12h 35m—of Twilight 1h 34m					
13 Su	Hyades rises 10 eve.											☿	☿	5 35	6 14	7 5	5 38	6 13	7 9	1 18			
14 M	Holy Cross. ♂ 2° N. of ☉											☿	☿	5 36	6 12	7 27	5 39	6 12	7 35	2 10			
15 Tu	Altair mer. 8 eve.											☿	☿	5 38	6 10	7 52	5 40	6 10	8 5	3 3			
16 W	Ember Day											☿	☿	5 39	6 8	8 22	5 41	6 8	8 40	3 59			
17 Th	Rigel rises 12 eve.											♂ ♀ ☿	☿	5 40	6 6	9 1	5 42	6 7	9 23	4 57			
18 Fr	Ember Day											☿	☿	5 41	6 5	9 49	5 43	6 5	10 14	5 56			
19 Sa	Ember Day											☿	☿	5 42	6 3	10 48	5 44	6 3	11 12	6 59			
38. 16th Sunday after Trinity																		Length of Day 12h 17m—of Twilight 1h 33m					
20 Su	Pollux rises 12 eve.											♂ ♀ ☾	☿	5 44	6 1	11 54	5 45	6 2	morn.	7 47			
21 M	St. Matthew ☿ Gr. El. W. of ☉											☿	☿	5 45	6 0	morn.	5 46	6 0	12 16	8 38			
22 Tu	☾ rises 1-3 mo.											☿ Per.	☿	5 46	5 59	1 4	5 47	5 59	1 22	9 25			
23 W	Autumn begins											☿	☿	5 47	5 57	2 13	5 48	5 57	2 27	10 8			
24 Th	Arcturus sets 9 eve.											☿	☿	5 48	5 55	3 20	5 49	5 55	3 30	10 49			
25 Fr	☿ rises 6-8 eve.											☿	☿	5 50	5 53	4 25	5 50	5 53	4 31	11 28			
26 Sa	☾ Apogee. ☾ Total Ecl.											M	☿	5 51	5 51	rises	5 51	5 52	rises	morn.			
39. 17th Sunday after Trinity																		Length of Day 11h 58m—of Twilight 1h 31m					
27 Su	Aquila mer. 7-8 eve.											☿	☿	5 52	5 49	6 13	5 52	5 50	6 17	12 7			
28 M	Harp mer. 6-7 eve.											☿	☿	5 53	5 47	6 29	5 53	5 48	6 37	12 46			
29 Tu	St. John & All Angels											☿	☿	5 55	5 46	6 48	5 54	5 47	6 59	1 27			
30 W	Capella rises 6:18 eve.											☿	☿	5 56	5 44	7 10	5 55	5 45	7 26	2 10			



MOON'S PHASES										Sun on Meridian Civil Time			MOON'S PLACE	CALENDAR for New Eng., N. York, Mich., Wis., Minn., N. and S. Dak., Mont., Wyo., Ida., Wash. and Oregon.			CALENDAR for N.J., Pa., Md., Del., Va., W. Va., Ky., Ind., O., Ill., Mo., Ia., Kans., Neb., Colo., Utah, Nev., and No. Cal.			Moon's Southing or Meridian Passage
Eastern Time					Central Time									Sun rises			Sun sets			
D.	H.	M.	D.	H.	M.	D.	H.	M.	S.	H.M.	H.M.	H.M.		H.M.	H.M.	H.M.	H.M.			
4	3	15E	4	2	15E	1	11	49	52											
11	8	6M	11	7	6M	11	11	46	56											
18	4	20M	18	3	20M	21	11	44	47											
26	8	34M	26	7	34M	28	11	43	54											
Day Astronomy, Church Days, etc.																				
1	Th	Algol (var.) mer. 2:19 mo.								☾	5 57	5 42	7 37	5 56	5 44	7 57	2 56			
2	Fr	Atonement								M ☾	5 58	5 40	8 15	5 57	5 42	8 37	3 46			
3	Sa	7-Stars mer. 3 mo.								☾	6 0	5 38	9 3	5 58	5 40	9 27	4 40			
40. 18th Sunday after Trinity										Length of Day 11h 40m—of Twilight 1h 30m										
4	Su	Aquila mer. 6-7 eve.								☿	6 1	5 36	10 3	5 59	5 39	10 27	5 36			
5	M	El Nath mer. 7 mo.								☿	6 2	5 34	11 14	6 0	5 37	11 35	6 34			
6	Tu	Menkar mer. 2 mo.								☿	6 3	5 32	morn.	6 0	5 35	morn.	7 30			
7	W	Menkar rises 7:43 eve.								☿ ☽	6 5	5 31	12 33	6 1	5 34	12 50	8 26			
8	Th	Capella mer. 4 mo.								☿	6 6	5 29	1 55	6 2	5 32	2 6	9 19			
9	Fr	Farmers' Day, Fla.								☿	6 7	5 27	3 18	6 4	5 31	3 24	10 11			
10	Sa	Perigee								☿	6 8	5 25	4 40	6 4	5 29	4 42	11 2			
41. 19th Sunday after Trinity										Length of Day 11h 22m—of Twilight 1h 31m										
11	Su	P.E.Sun.inv.U.S. ☐ ♀ ☉ ☿ ☽ ☾								☿	6 10	5 23	6 4	6 6	5 28	6 0	11 54			
12	M	Columbus Day								☿	6 11	5 22	sets	6 7	5 26	sets	ev. 47			
13	Tu	♄ mer. 12 eve.-2 mo.								☿	6 12	5 20	6 19	6 8	5 24	6 35	1 44			
14	W	Orion's Belt mer. 3-5 mo.								☿	6 14	5 18	6 54	6 9	5 23	7 15	2 43			
15	Th	♄ sets 9-11 eve.								☿	6 15	5 16	7 40	6 10	5 22	8 4	3 44			
16	Fr	Alpheratz mer. 10:23 eve.								☿	6 16	5 15	8 37	6 11	5 20	9 2	4 44			
17	Sa	♄ mer. 6-8 eve.								☿ ☽	6 18	5 13	9 43	6 12	5 18	10 5	5 41			
42. 20th Sunday after Trinity										Length of Day 11h 4m—of Twilight 1h 32m										
18	Su	St. Luke								☿	6 19	5 11	10 50	6 13	5 17	11 12	6 34			
19	M	Algerib mer. 10:17 eve.								M ☿	6 20	5 9	morn.	6 14	5 16	morn.	7 22			
20	Tu	Hyades mer. 3-4 mo.								M ☿	6 21	5 8	12 2	6 15	5 14	12 18	8 7			
21	W	☐ of Pegasus mer. 9-10 eve.								☿	6 23	5 6	1 11	6 16	5 13	1 22	8 48			
22	Th	Mira (var.) mer. 12 eve.								☿	6 24	5 4	2 16	6 17	5 11	2 23	9 28			
23	Fr	Arbor Day, S. Dakota & Ill.								☿	6 26	5 3	3 20	6 18	5 10	3 23	10 6			
24	Sa	♄ Apogee								☿	6 27	5 1	4 23	6 19	5 9	4 22	10 46			
43. Kingdom of Christ										Length of Day 10h 46m—of Twilight 1h 33m										
25	Su	Job's Coffin mer. 6-7 eve.								☿	6 28	5 0	5 26	6 21	5 7	5 22	11 26			
26	M	Vega sets 1:20 mo.								☿	6 29	4 59	rises	6 22	5 6	rises	morn.			
27	Tu	♄ mer. 8-10 eve.								☿	6 31	4 57	5 15	6 23	5 5	5 30	12 8			
28	W	SS. Simon and Jude								☿	6 32	4 55	5 41	6 24	5 3	6 0	12 54			
29	Th	Lyra sets 0-2 mo.								☿	6 34	4 54	6 15	6 25	5 2	6 37	1 43			
30	Fr	☿ rises 11 eve.-1 mo.								M ☿	6 35	4 52	7 0	6 26	5 1	7 23	2 35			
31	Sa	Hallowe'en								☿	6 36	4 51	7 55	6 27	5 0	8 19	3 31			

Eleventh
Month



November



Thirty
Days

MOON'S PHASES					Sun on Meridian			CALENDAR for New Eng., N. York, Mich., Wis., Minn., N. and S. Dak., Mont., Wyo., Ida., Wash. and Oregon.					CALENDAR for N.J., Pa., Md., Del., Va., W. Va., Ky., Ind., O., Ill., Mo., Ia., Kans., Neb., Colo., Utah, Nev., and No. Cal.					Moon's Southing or Meridian Passage								
Eastern Time			Central Time		Civil Time			MOON'S PLACE					Sun		Moon		Sun		Moon							
D. H. M.			D. H. M.		D. H. M.								rises		sets		rises		sets							
D. H. M.			D. H. M.		D. H. M.								H.M.		H.M.		H.M.		H.M.							
☾	3	2	17M	3	1	17M	1	11	43	40												morn.				
☾	9	5	55E	9	4	55E	11	11	44	2																
☾	16	9	13E	16	8	13E	21	11	45	48																
☾	25	2	10M	25	1	10M	28	11	47	50																
Day Astronomy, Church Days, etc.							MOON'S PLACE					Sun rises H.M.		Sun sets H.M.		Moon rises H.M.		Moon sets H.M.								
44. 22nd Sunday after Trinity																						Length of Day 10h 30m—of Twilight 1h 34m				
1	Su	All Saints										☾	6	38	4	49	9	2	6	28	4	58	9	24	4	27
2	M	All Souls					M					☾	6	39	4	48	10	16	6	30	4	57	10	34	5	23
3	Tu	General Elections										☾	6	40	4	46	11	34	6	31	4	56	11	48	6	17
4	W	☾ rises 11 eve.-1 mo.					♂ ♀					☾	6	42	4	45	morn.		6	32	4	55	morn.		7	9
5	Th	☾ rises 7-9 eve.										☾	6	43	4	44	12	53	6	33	4	54	1	2	7	59
6	Fr	☾ rises 0-2 mo.										☾	6	44	4	42	2	13	6	34	4	53	2	16	8	48
7	Sa	Fomalhaut mer. 8 eve.					♂					☾	6	46	4	41	3	33	6	35	4	52	3	32	9	38
45. 23rd Sunday after Trinity																						Length of Day 10h 15m—of Twilight 1h 35m				
8	Su	☾ Perigee					M					☾	6	47	4	40	4	55	6	36	4	51	4	49	10	30
9	M	☾ mer. 11 eve.-1 mo.					M					☾	6	49	4	39	6	20	6	38	4	50	6	8	11	25
10	Tu	☾ sets 5-7 eve.										☾	6	50	4	37	sets		6	39	4	49	sets		ev.	24
11	W	Armis. Day, Tex.					♂ ♀					☾	6	51	4	36	5	28	6	40	4	48	5	50	1	25
12	Th	Sirius mer. 3:18 mo.										☾	6	53	4	35	6	21	6	41	4	47	6	46	2	28
13	Fr	Capella mer. 1:39 mo.					M					☾	6	54	4	34	7	25	6	42	4	46	7	49	3	28
14	Sa	☾ mer. 8-10 eve.					♂ ♀					☾	6	56	4	33	8	36	6	43	4	45	8	57	4	25
46. 24th Sunday after Trinity																						Length of Day 10h 0m—of Twilight 1h 36m				
15	Su	Mirach mer. 9 eve.					☾					☾	6	57	4	32	9	48	6	44	4	44	10	5	5	16
16	M	Andromeda mer. 8-10 eve.										☾	6	58	4	31	10	58	6	46	4	44	11	11	6	3
17	Tu	Orion's Belt mer. 1-2 mo.										☾	7	0	4	30	morn.		6	47	4	43	morn.		6	46
18	W	Whale mer. 8-11 eve.										☾	7	1	4	29	12	6	6	48	4	42	12	14	7	26
19	Th	♀ 4' N. of ♂										☾	7	2	4	28	1	10	6	49	4	41	1	15	8	5
20	Fr	☾ Apogee										☾	7	4	4	27	2	13	6	50	4	41	2	14	8	44
21	Sa	Aquila sets 10 eve.					♂ ♀					☾	7	5	4	26	3	16	6	51	4	40	3	13	9	33
47. 25th Sunday after Trinity																						Length of Day 9h 47m—of Twilight 1h 35m				
22	Su	☾ sets 2-4 mo.										☾	7	6	4	25	4	20	6	52	4	39	4	13	10	5
23	M	☾ mer. 2-4 mo.										☾	7	8	4	25	5	26	6	54	4	39	5	15	10	50
24	Tu	Great + sets 1-2 morn.					M					☾	7	9	4	24	6	34	6	55	4	38	6	18	11	38
25	W	St. Catherine										☾	7	10	4	23	rises		6	56	4	38	rises		morn.	
26	Th	Thanksgiving Day					M					☾	7	11	4	23	4	57	6	57	4	37	5	20	12	30
27	Fr	☾ mer. 6-8 eve.					☾					☾	7	13	4	22	5	50	6	58	4	37	6	14	1	26
28	Sa	☾ sets 9-11 eve.					M					☾	7	14	4	22	6	54	6	59	4	37	7	17	2	22
48. 1st Sunday in Advent																						Length of Day 9h 36m—of Twilight 1h 35m				
29	Su	Riegel rises 7 eve.					M					☾	7	15	4	21	8	7	7	0	4	36	8	26	3	19
30	M	St. Andrew										☾	7	16	4	21	9	23	7	1	4	36	9	38	4	13



MOON'S PHASES						Sun on Meridian			CALENDAR for				CALENDAR for				Moon's Southing or Meridian Passage
Eastern Time			Central Time			Sun on Meridian Civil Time			New Eng., N. York, Mich., Wis., Minn., N. and S. Dak., Mont., Wyo., Ida., Wash. and Oregon.				N. J., Pa., Md., Del., Va., W. Va., Ky., Ind., O., Ill., Mo., Ia., Kans., Neb., Colo., Utah, Nev., and No. Cal.				
D.	H.	M.	D.	H.	M.	D.	H.	M.	Sun rises	Sun sets	Moon rises	Sun rises	Sun sets	Moon rises	morn.		
									H.M.	H.M.	H.M.	H.M.	H.M.	H.M.	H.M.		
☾	2	11 50M	2	10 50M	1	11 48 53			7 17	4 20	10 40	7 2	4 36	10 50	5 5		
☾	9	5 16M	9	4 16M	11	11 53 4			7 19	4 20	11 57	7 3	4 35	morn.	5 54		
☾	16	5 43E	16	4 43E	21	11 58 54			7 20	4 20	morn.	7 4	4 35	12 2	6 42		
☾	24	6 23E	24	5 23E	28	12 1 22			7 21	4 19	1 14	7 5	4 35	1 15	7 30		
☾	31	8 23E	31	7 23E	31	12 2 50			7 22	4 19	2 32	7 6	4 35	2 28	8 19		
Day Astronomy, Church Days, etc.																	
1	Tu	☽ rises 4-6 mo.				☾ 21	☾	7 17	4 20	10 40	7 2	4 36	10 50	5 5			
2	W	Algenib mer. 7:24 eve.					☾	7 19	4 20	11 57	7 3	4 35	morn.	5 54			
3	Th	Rigel mer. 0:13 mo.				☾ Gr. El. E.	☾	7 20	4 20	morn.	7 4	4 35	12 2	6 42			
4	Fr	Arbor Day, Ga.					☾	7 21	4 19	1 14	7 5	4 35	1 15	7 30			
5	Sa	☽ mer. 9-11 eve.					☾	7 22	4 19	2 32	7 6	4 35	2 28	8 19			
49. 2nd Sunday in Advent									Length of Day 9h 28m—of Twilight 1h 36m								
6	Su	☽ Perigee					☾	7 23	4 19	3 53	7 7	4 35	3 43	9 10			
7	M	Menkar mer. 9:52 eve.					☾	7 24	4 19	5 16	7 8	4 35	5 1	10 6			
8	Tu	Sirius mer. 1:32 mo. ♀ in Aph.					☾	7 25	4 18	6 30	7 9	4 35	6 20	11 5			
9	W	Capella mer. 12 eve.					☾	7 26	4 18	sets	7 10	4 35	sets	ev 7			
10	Th	Altair sets 9 eve.				☾ ☽ ☽	☾	7 27	4 18	5 4	7 10	4 35	5 29	1 10			
11	Fr	☽ mer. 7-9 eve.				☽ ☽ ☽	☾	7 28	4 18	6 14	7 11	4 35	6 36	2 9			
12	Sa	☽ sets 5-7 eve.					☾	7 29	4 18	7 27	7 12	4 35	7 46	3 5			
50. 3rd Sunday in Advent									Length of Day 9h 22m—of Twilight 1h 37m								
13	Su	☽ mer. 1-3 mo.				M	☾	7 30	4 19	8 40	7 13	4 35	8 55	3 54			
14	M	Castor mer. 2 mo.					☾	7 30	4 19	9 50	7 14	4 35	10 0	4 40			
15	Tu	Kids mer. 11 eve.					☾	7 31	4 19	10 57	7 14	4 36	11 3	5 22			
16	W	Ember Day. Close ☽ ♀ & ♂					☾	7 32	4 19	morn.	7 15	4 36	morn.	6 1			
17	Th	Hercules sets 6 eve.					☾	7 33	4 20	12 1	7 16	4 36	12 3	6 40			
18	Fr	Ember Day. ☽ Apogee				☾	☾	7 33	4 20	1 4	7 16	4 37	1 2	7 19			
19	Sa	Ember Day. ☽ ♀ b Close.					☾	7 34	4 20	2 8	7 17	4 37	2 1	8 0			
51. 4th Sunday after Advent									Length of Day 9h 19m—of Twilight 1h 37m								
20	Su	☽ sets 8-10 eve.					☾	7 34	4 21	3 12	7 18	4 37	3 2	8 43			
21	M	St. Thomas ☽ ♀ ☉ Inf.					☾	7 35	4 21	4 19	7 18	4 38	4 5	9 30			
22	Tu	Winter begins					☾	7 36	4 22	5 29	7 19	4 38	5 10	10 21			
23	W	Orion mer. 11-12 eve.					☾	7 36	4 22	6 37	7 19	4 39	6 11	11 16			
24	Th	Aldebaran mer. 10 eve.					☾	7 36	4 23	rises	7 20	4 40	rises	morn.			
25	Fr	Christmas Day					☾	7 37	4 23	4 43	7 20	4 40	5 6	12 14			
26	Sa	St. Stephen					☾	7 37	4 24	5 55	7 20	4 41	6 15	1 12			
52. 1st Sunday after Christmas									Length of Day 9h 20m—of Twilight 1h 37m								
27	Su	☽ rises 7-9 eve.					☾	7 38	4 24	7 12	7 21	4 41	7 28	2 8			
28	M	Holy Innocents ☽ 21					☾	7 38	4 25	8 30	7 21	4 42	8 42	3 1			
29	Tu	Betelgeuse mer. 12 eve.					☾	7 38	4 26	9 48	7 21	4 43	9 54	3 52			
30	W	Capella mer. 10:34 eve.					☾	7 38	4 27	11 4	7 22	4 43	11 6	4 40			
31	Th	St. Sylvester. New Year's Eve					☾	7 38	4 28	morn.	7 22	4 44	morn.	5 27			

CALENDAR OF THE ANCIENT BOLIVIANS

In western Bolivia, about twelve miles from the southern end of Lake Titicaca and not far from the Peruvian frontier, a group of very ancient ruins was discovered not very long ago. These ruins include the remains of several large buildings, monolithic doorways and broken statues. Many of the gigantic blocks of stone which had been used in the structures found, were elaborately sculptured and fitted together with great skill.

These ruins had been abandoned long before the Spanish conquest. The Indians knew nothing about their origin, but there were some traditions which attributed them to the Incas, while others connected them with the Piruas, the rulers of a very ancient people known as the Hatun Runas, who lived in the highlands of Peru and Bolivia long before the rise of the Inca dynasty.

It was in the ruins in that locality, attributed to the Tiahuanacans, that Prof. Arthur Posnansky, the noted German archaeologist, discovered a calendar of the ancient Bolivians, sculptured on a big stone. According to his description, the calendar of that ancient and remarkably advanced race was based on a year of twelve months, each consisting of three weeks of ten days each. The odd days were used as national or religious holidays.

Dr. Posnansky expressed the opinion, that the calendar of the ancient inhabitants of Tiahuanacu was in many respects far superior to our present calendar and that its substitution for the prevailing method of dividing the year would be a wise step, as it would mean the avoidance of many complications and inconveniences.

THREE LAYERS TO THE OCEAN

The ocean, which to the popular mind represents merely a large body of salt water, is really not so simple as that. Researches under auspices of the Carnegie Institution of Washington reveal that there are at least three different kinds of water in the ocean. This find is based to a large extent on the deep sea determinations of the non-magnetic ship *Carnegie*, which was destroyed with the loss of Captain Ault and the cabin boy in Western Samoa last November.

Analysis of the various water samples collected by the Carnegie party shows that the ocean may be divided into three layers, according to a recent report to the American Geophysical Union. First of all there is a layer where active plant and animal life is maintained. Beneath this is a middle layer in which a decomposition of organic remains takes place. Furthest down is water that has been conducted from polar regions.

The topmost layer contains large quan-

ties of valuable dissolved oxygen, but low values of phosphates, silicates and hydrogen in concentrated form. In the second layer oxygen values are low, but quantities of phosphates and silicates are relatively high. The third layer tends to compare with conditions of the surface water.

With the aid of a shotgun and a stopwatch the scientists were able to determine the distance to the bottom of the ocean when the sonic depth-finding apparatus aboard the ship was broken.

The apparatus improvised to replace the broken device consisted of a steel breech just long enough to hold a 16-gauge shotgun shell, which was screwed into one end of a length of brass pipe. The pipe acted as a holder and guide for a heavy steel firing-pin dropped into its upper end. The shell end was held a foot or two below the surface. Hydrophones were used to pick up the echo of the shot and a stopwatch measured the elapsed time.—*N. Y. Times*.

INDEX OF THE UNIVERSE

Telling his audience that he was going to take it "to look at the universe, from outside; a high adventure armed with the instruments of science," Professor Harlow Shapley, director of Harvard's Astronomical Observatory, explained a system of classification of all known systems of material bodies in a Commerce Building of the College of the City of New York. The momentous scheme which embraces the material world from the infinitesimally tiny protons and electrons through the scale to star systems "more than a thousand million trillion miles across" and on to the "space-time complex," was greeted as comparable to the classification Linnaeus made in the field of biology.

MAJOR CLASSES LISTED

There are seventeen major classes in the plan as outlined by Professor Shapley, but the ends are left open—"a confession of ignorance and a confession of faith," Professor Shapley said. He predicted that in thirty years science will have advanced enough to fill in No. 7 on the minus side of his classification.

"We are on the foothills of knowledge, making our survey of the world," he said, "catching glimpses of cosmic evolution."

Mankind in the scale is pigeonholed in the minus side, within a parenthetical subdivision of the class of colloidal aggregates.

The classification, worked out in the past year, follows:

SYSTEM IN DETAIL

- 7.
- 6. Corpuscles
 - Quanta.
 - Protons.
 - Electrons.
- 5. Atoms (Hydrogen to Uranium).
- 4. Molecules. (1 to infinity).
- 3. Molecular Aggregates.
 - I. Crystals.
 - II. Colloids.
- 2. Colloidal and Crystallic Aggregates.
 - A. Inorganic substances (e.g. minerals, meteorites, clouds).

- B. Organic substances (e.g. organisms, colonies).
 - (Mankind falls in this subdivision).
- 1. Meteoritic Associations.
 - 1. Comets.
 - 2. Meteor streams.
 - 3. Diffuse nebulae.
- 00 Satelitic systems.
 - I. Earth-Moon type.
 - II. Jovian type.
 - III. Saturnian type.
- 1. Planetary structures. (The earth is in this classification.)
 - I. Stars, with corona and meteors.
 - II. Stars, with planets, comets, &c.
 - III. Stars with nebulous rings or envelopes.
- 2. Double and multiple stars.
 - I. Close systems.
 - II. Visual systems.
 - III. Moving pairs.
- 3. Galactic clusters.
 - a. Field irregularities.
 - b. Star associations.
 - c. Very loose groups.
 - d. Loose groups.
 - e. Restricted groups.
 - f. Compact groups.
 - g. Dense groups.
- 4. Globular Clusters.
- 5. Star Clouds.
- 6. Galaxies.
- 7. Super-Galaxies.
 - I. Como-Virgo type.
 - II. Home Galaxy.
- 8. Groups of Super-Galaxies.
 - 1. Double groups.
 - 2. Complex assemblages.
 - 3.
- 9. The Cosmoplasma.
 - Cosmic meteors.
 - Diffused nebulosity.
 - Interstellar gas.
 - Interstellar electrons and protons.
 - Radiation.
 -
- 10. The Universe (the space-time complex).
- 11.
 - Subclassifications are: Unmarked listing,

according to nature; 1, 2, &c., according to mass; A, B, &c., according to appearance; I, II, &c., according to structure.

WILL ORDER THINKING

The classification will afford a skeleton to bring order out of chaos and is intended as a guide to work and contemplation. It aims toward a proper perspective and serve to interpret some phases of the side-real universe in clearer form than before.

As a matter of convenience, or perhaps of vanity, No. 1 is given to that class where our earth appears as part of a stellar structure.

In our developing sequence it is time to turn again toward the large. From the tiny moons of Mars and Saturn to the great star clouds of the Milky Way is a long road, but it leads directly on to the realm of galaxies.

There is no doubt of the existence of our total Milky Way system as a gravitational unit. It may be irregular and loosely organized; possibly it is expanding or disintegrating irregularly. We know little of it as yet. But its form, its flatness and the distribution of stars within are sure indicators of a physical system.

Number 10 in the scale—the universe—is inclusive of the systems classified by numbers preceding.

As we approach the all-inclusive system—the four dimensional space-time complex—we realize that certain elements of the material universe have not been included. In fact, the major part of all material things has been left out, provided we adopt the current view of the relation of mass, matter and energy.

Though admitting defeat at both extremes, we consider this complete and satisfactory in the main.—*N. Y. Times*.

RECENT PROGRESS IN COSMOLOGY

See also Vols. III, pp. 101-107; IV, pp. 22-25, V, pp. 19-20.

There is no science which covers a larger field than Cosmology, or deals almost entirely with subjects so far out of reach as those of that science. If we consider the difficulties with which Cosmology has to contend to make observations and to establish facts upon which the structure of the science should rest, we cannot help being surprised at the progress achieved by it long before the invention of the telescope and of the numerous other instruments of precision available to cosmologists of the present day. On the other hand, we should not be surprised that many of the observations made many centuries ago and which were used as the basis of general conclusions and theories, were inaccurate, making the deductions and theories based upon them naturally wrong.

Each new instrument of precision invented and each improvement in the efficiency of instruments for observation, measurement, etc., in more recent years enabled the cosmologists not only to extend the range of observation, but also to correct figures and other data collected in the past and to modify or entirely discard the theories based upon such wrong data. As the past fifty years have witnessed a remarkable improvement in the power and precision of practically all instruments used in cosmological work, it is not surprising that in that time many important new discoveries were made and many of the errors committed in the past were corrected.

The efforts to improve the capacity and exactness of the instruments used in the study of the universe still continue. One of the most convincing evidences is the undertaking of building a gigantic new telescope of the reflector type, with a mirror 200 inches in diameter. When completed, this latest telescope, according to estimates made by Dr. Elihu Thomson, will make it possible for the human eye to penetrate space four times as far as has been possible with any other telescope ever built before.

WHAT THE 200-INCH TELESCOPE MAY MEAN TO SCIENCE

The telescope was invented in the 16th century. Cosmology has progressed far

more in a hundred years than formerly in a thousand. Every improvement in the structure, accuracy and penetrating power of the instruments, which in the beginning had been rather crude, extended our power to penetrate space, thus opening up to our vision regions undreamed of before. Yet, every time when a more powerful telescope had been installed and tried out, many of the cosmologists, although they admitted that our range of vision had been markedly extended by the new instrument, were inclined to believe that we had actually reached the limits of space and therefore could not go beyond the new limits reached. Of course, the installation of the next, even more powerful, telescope convinced the narrow-minded doubters that their ideas had been wrong; yet, either they or other cosmologists again expressed the conviction that the limits of space had been reached, which naturally made it useless to extend our vision, as there was no more to be seen. Even after the 100-inch Mount Wilson telescope had been tried out and had proved beyond reasonable doubt that once more the range of our vision in space had been enormously extended, a number of cosmologists expressed the opinion that now, surely, the limit of the universe had been reached. The obvious fact, that with the increase of distance the number of visible stars diminishes, was used by them as an argument to support their theory.

The great majority of cosmologists, although admitting that logically there must be a limit to the extent of the universe, are convinced that we have not yet reached the limits of space and that the 200-inch telescope, when completed, will prove it, by bringing before our vision regions of cosmic space with undreamed of star systems so far away, that their light, traveling at a speed of 186,411 miles a second, would require more than 400,000,000 years to reach us. Some of the scientists are even more hopeful and believe, that with the new telescope it will be possible to penetrate space to a distance of nearly one billion light-years.

The possibilities which the new telescope will undoubtedly offer to cosmology are enormous. If we consider that this new instrument, according to careful cal-

culations, will be able to make visible to our eye the light of an ordinary candle at a distance of 41,000 miles, it will undoubtedly make it possible for us to make more thorough and detailed observations of our satellite, the moon, as well as of the other planets of our sun, than has been possible for us heretofore with the instruments at our disposal.

With the aid of the new telescope we shall, undoubtedly, gain much additional information about the moon and the planets, which may enable us not only to add to our stock of information concerning these cosmic bodies, but also to correct some of the conclusions which had been drawn from the imperfect and often deceptive data obtained by former observations.

One particularly interesting cosmological problem, to the clearer understanding of which the new telescope, with its so immensely superior penetrating power, is expected to contribute materially, is presented by the nebulae, particularly the spiral nebulae, of which about one million are already known. The distance of those which are but faintly visible by the aid of the 100-inch Mt. Wilson telescope, is estimated at between 70 and 80 million light-years. It is hoped that the new telescope will not only increase the visibility of the spiral nebulae already known and give a clearer insight into their structure, but that it will bring others within the range of our vision, which, owing to the limitation of power of the already existing telescope, have not yet been discovered. Whether even the high power of the 200-inch instrument will make it possible to solve the problem of the exact nature of these nebulae, whether they consist merely of a haphazard cloud of cosmic matter, perhaps in gaseous form, or whether they are independent universes, similar in their structure to the universe of which our solar system forms a part, is extremely doubtful.

A NEW PLANET OR A COMET?

It was on January 21, 1930, that Clyde Tombaugh, connected with the Lowell Observatory, Flagstaff, Ariz., discovered on one of the exposed and developed photographic plates a "blotch of light" which he could not explain. Later he mentioned the matter to Dr. V. M.

Slipher, the director of the observatory, and to Assistant Director Dr. C. O. Lamp-land and showed them the plate. After a careful examination of that plate and of photographs of the same part of the firmament taken before, which also showed that spot, Dr. Slipher and his assistant began a thorough investigation of the problem before them. They found that the problematic spot was located quite near to the place in which, according to the prediction made in 1914, two years before his death, by Dr. Percival Lowell, the founder of the observatory, another planet would be discovered.

After diligent research, in which they were assisted by observers in other observatories, Dr. Slipher came to the conclusion that the faint blotch on the photographic plates was really caused by the presence of a new planet of our solar system and that it was located in almost the same place where, as Dr. Lowell had predicted in 1914, it would be found. To honor the memory of Dr. Lowell, the discovery of the new planet was published on March 13th, the 75th anniversary of the birth of the founder of the observatory. He had based his prediction on mathematical calculations, which he had made to determine the position of the unknown factor, which was responsible for certain inexplicable irregularities in the orbits of other planets. It had been principally his belief that it was the gravitational attraction of some other, still unknown planet, which caused certain deviations in the orbit of Neptune, that had led Dr. Lowell to make these calculations.

The news of the discovery of a new trans-Neptunian planet had scarcely made its way around the world, when a number of astronomers, some in England, others in Germany and a few in the United States, expressed the opinion that the newly discovered astral body is not a new planet, but more likely a comet or an asteroid and submitted a number of arguments supporting their theory.

In answer to these doubters, not only Dr. Slipher and his assistants at the Lowell Observatory, but also astronomers from other observatories, among them Prof. George Van Biesbroeck of the Yerkes Observatory, Sir James Jeans, the British astronomer and secretary of the British Royal Society, and H. R. King-

ston, President of the Royal Astronomical Society of Canada, have issued statements in which they express their full confidence in the correctness of the claim that the astral body discovered recently and since then named Pluto, is the trans-Neptunian planet predicted sixteen years ago by Dr. Lowell.

Of course, it is admitted, the data about the new, ninth planet, relating to its distance from the sun, its size, orbit, speed of motion, its physical condition, etc., are still somewhat vague, as the time since its discovery has not been long enough to collect such information with the necessary degree of exactness in such short a time. According to the data so far collected from observations and mathematical calculations, the new planet is approximately forty-one times as far from the earth as the earth is from the sun. It shows a yellowish color, which suggests an albedo and density like those of the inner planets. Its size and mass seem to be about the same as those of Mars. The orbit of Pluto is undoubtedly elliptical, but the dimensions of the two axes of the orbit have not yet been ascertained, nor have the rotary and orbital speeds of motion been accurately measured.

As to the question, whether there is any possibility of life even in the most primitive form existing on the new planet, the astronomers agree that life of any form is impossible on Pluto. Owing to its great distance from the sun, the temperature prevailing on that planet must be extremely low. Sir James Jeans estimates the surface temperature on Pluto to be about 200 degrees Celsius below Zero, or about 400 degrees Fahrenheit below freezing, a degree of cold which would cause even oxygen to become solid.

Not only at the Lowell Observatory, but also at other institutions in the United States and in Europe, the new planet undoubtedly will be most carefully observed and every effort will be made to collect all obtainable data in regard to it. It is hoped, however, that a year from now, all doubts of its being a planet will be removed and much accurate information concerning its distance, size, orbit, etc., will have been collected. It is even hoped that the careful study of the new planet probably will lead to the discovery of two or three other planets, the existence of which has been suspected for many years.

WHAT THE SUN MEANS TO US

That the sun is of great importance to man and all other living beings on earth was recognized by the human race many thousands of years ago, long before the race had emerged from its primitive stage of mental development. In a general way it was understood that the sun is the most important source of light and heat to the earth and all life on it, but about the why and how practically nothing was known. That state of ignorance continued to the beginning of the 19th Century. During the first half of that century physical science and chemistry made some progress and discoveries were made, which threw an unexpected light upon certain phases and activities in the universe, which seemed to indicate that some of the theories, generally accepted for many centuries, were not entirely correct, perhaps altogether wrong.

These discoveries had a tendency to stimulate the desire to learn more about cosmic bodies, cosmic forces and about the relations existing between them. A great deal of work was done in that respect during the second half of the 19th Century and the results increased in volume and importance, as the work became more systematized and to the point. The most remarkable progress, however, was made during the thirty years since the beginning of the 20th Century. Improved methods of observation made possible by more highly perfected instruments and apparatus and the collaboration of various other sciences, like physics, chemistry, geology, etc., with cosmology, have led to results during the past thirty years far greater than ever reached before during a period of a hundred or even a thousand or several thousand years.

That the sun is the "*conditio sine qua non*" for all life, human, animal or vegetable, on our earth, had been suspected for many thousand years, but the reasons were either unknown or only surmised from observations not fully understood. Although, even now, our knowledge and understanding of the subject is by no means complete, we are incomparably better able to answer the question: "What does the sun mean to us?" than ever before.

On the occasion of a visit to the University of Gratz, Styria, Prof. J. Plotnikow, a noted scientist, answered that question by giving a comprehensive résumé,

based upon the most recently established scientific facts, of the powerful influences which the sun exerts over all life on our planet.

The sun sends out its rays of energy through the world ether with a speed of 186,411 miles a second. Of course, only an infinitesimal part of the energy radiated by the sun is received by the earth, yet its share is considerable. Expressed in calories, the earth receives at the periphery of its atmosphere 2 calories a minute for each square centimeter. That means, that during one year, the total for the whole earth amounts to approximately 1.68×10.24 calories, of which only an insignificant fraction is utilized to maintain the life of the human race.

The radiations sent out by the sun are conveyed by energy rays, the specific character and effect of which depend upon their wave-length. Expressed by calories, the energy conveyed by the different rays, which are given in their order, from the longest, electric waves down to the shortest known waves of the cosmic rays, are as follows:

Long electric waves, O.O. cal.; short electric waves, 30 cal.; heat-rays 30,000 cal.; ultra violet rays, from 100,000 to 300,000 cal.; Roentgen-rays, from 30 million to three billion cal.; Cosmic rays, 3.10^{12} cal.

The rays which are of the greatest importance to animal and plant organisms are naturally those which produce the chemical actions involved in the life process. After a long and careful study of the matter it was learned that only rays of a certain wavelength were absorbed by organic substances, and only these absorbed rays produced chemical changes, while those rays with too long or too short wavelength either passed through matter or were reflected by it without causing any chemical change.

It was found that the range of the chemically most powerful rays lies between the wavelengths from 300 to 200 millimicrons, which includes the blue and the violet part of the visible spectrum and the ultra-violet rays, which are the most powerful in chemical action. From that most powerful group of rays, both in the direction of the long-wave electric rays and in that toward the extremely short-waved cosmic rays, the chemical potency

tapers down to practically nothing, so far as organic life is concerned.

The earth is surrounded by an atmosphere which is believed to extend to a height of about fifty miles. It is considered to consist of two layers, the troposphere, which extends from the surface of the earth to a height of approximately seven miles, and the stratosphere which is beyond it and extends to about fifty miles from the earth's surface. It is in the troposphere where all the atmospheric phenomena, like clouds, rains, thunderstorms, winds, etc., are developed and take place. In the stratosphere no such disturbances occur, because the gases contained in it are greatly rarefied and in a rigid condition.

All the rays emanating from the sun, which reach the earth, must first pass through the atmosphere surrounding our planet. Most of the rays pass through it without much interference, like the heat rays, the visible light rays, the cosmic rays, and the long-wave electric rays. Only the ultra-violet rays, or at least a part of them, are more or less interfered with, while the cathode rays do not get beyond the outer layer of the stratosphere. These rays are stopped and absorbed by the gases of the stratosphere, which thereby become greatly ionized. These ionized gases form around the outside of the stratosphere a strongly conducting shell of electrons with a potential of 200,000 volts, known as the Heavyside layer. It is quite probable that from this heavily charged electric field a continuous electric current passes through the atmosphere to the negatively charged earth, but nothing positive has been learned yet about the matter.

Nearly all the rays from the sun, which reach the earth are more or less of importance to the organic life. The heat rays, particularly those with a wavelength between 750 and 1200 millimicrons, have lately been discovered to penetrate organic substances to some extent, varying with the nature of the substance, and to produce certain chemical effects, which may be of importance to organisms. It is quite probable that the power of the heat rays to produce chemical effects increases with the diminution of their wavelength, but nothing definite is known about it so far.

All the rays of the visible light of the

sun, from the infra-red to the ultra-violet, are of vital importance to all living organisms. The red-orange rays, which are absorbed by the chlorophyl, bring about the assimilation by plants of the carbonic acid in the atmosphere, a reaction on which all organic life on this planet is based. The rays between the orange and the ultra-violet limit of the visible spectrum are also important for all vegetable and animal life, but in varying degrees. The short-waved blue, violet and ultra-violet rays are partly diffused by the atmosphere and produce the blue color of the sky. These rays are also of considerable effect upon the vegetable and animal life on the surface of the earth. The ultra-violet rays nearest to the visible part of the spectrum, with a wavelength between 300 and 400 millimicrons, are chemically very active, but do not seem to have much effect upon living organisms. But these rays ionize the gases of the atmosphere and generate atmospheric electricity which charges the clouds and produces lightning discharges. They also have the peculiar power to produce fluorescence.

The ultra-violet rays wavelengths between 320 and 280 millimicrons have various potent effects on the living organisms. Under certain conditions they produce sunburns on the human skin, but if used with moderation, merely gradual tanning. The rays within the same range also aid the development of vitamins.

The cosmic rays, which do not come from the sun, but from some part of the galaxy, possess great power of penetration, but science has not found out whether they exert any specific effect on living organisms.

Before closing the review of the vitally important and beneficial effects of the sun's radiations, to which all human, animal and plant organisms owe their existence, it is proper to state that many other effects may be involved, of the exact nature of which practically nothing is known. As many of the rays mentioned, excepting the heat rays and the light rays included in the visible spectrum, were practically unknown a comparatively short time ago, we may be justified in hoping that before long many of the still existing problems will also be solved.

THE RIDDLE OF THE COSMIC RAYS

Although several years have passed

since the discovery of the "Cosmic Rays," these powerful, invisible waves, which penetrate the atmosphere of our planet and, undoubtedly, play an important factor in all chemical and other life processes, nothing definite is known about their origin. Many noted scientists have taken up the study of these rays, a number of theories, all different, have been proposed, but the problem of the origin of these important rays is still unsolved.

Dr. Millikan has expressed the opinion, that the cosmic rays never vary in intensity and come from all directions and at all times without any change. This would mean, according to the interpretation of other scientists, that the cosmic rays are generated in the vacant spaces and are the result of the formation of new atoms under conditions of extreme cold and very low pressure.

Other scientists, among them Eddington and Jeans, expressed the opinion, that the cosmic rays are produced in the blazing furnaces of the stars the character of which greatly resembles that of our sun. Under the high temperature and extremely great pressure prevailing within these stars, atoms are annihilated and thereby powerful energy is released in the form of cosmic rays, which penetrate space in every direction.

Both these theories have been practically overthrown by two other investigators, by Kolhorster, a German scientist and Axel Corlin, connected with the Geophysical Observatory at Abisko, in northern Sweden. Using an apparatus invented by Kolhorster, these two scientists carefully measured the electrical effect produced by the cosmic rays. They found, that the intensity of the cosmic rays was by no means the same at all times, but that it varied considerably according to the phase presented by the earth to the region of the sky. Although the observation of this fact disproves the correctness of the theories formulated by Millikan and Eddington, it does not answer the question concerning the original source or sources from which the cosmic rays are derived. However, neither Corlin nor the other scientists intend to give up their studies and research, until this puzzling problem is solved or, at least, brought nearer to its solution.

IS THERE A LIMIT TO THE SIZE OF STARS?

Not until quite recently has it been possible to gauge, even approximately, the size of stars, even of those which are comparatively near to our solar system. The introduction of an ingenious instrument, the interferometer, at some of the leading observatories has made such measurements possible and has led to rather surprising results. By using an interferometer in connection with the 100-inch telescope of the Mount Wilson Observatory, F. G. Pease succeeded in measuring the size of a number of stars, among them Antares, in the constellation of the scorpion. The result was astonishing. It was found that Antares has a diameter of approximately 440,000,000 kilometers, compared with the diameter of about 1,391,000 kilometers of our sun. How enormous the size of Antares is will be better understood if we consider that our sun and part of its planetary system, including Mercury, Venus, the Earth and Mars, could find ample room to continue their planetary motions within Antares if it were hollow, with about 88,000,000 kilometers to spare on all sides.

Although Antares is the largest of the stars the size of which has been measured so far, there may be other stars of even larger dimensions. That possibility naturally suggests the question, how large may stars be? Is there no limitation—and if there is—what is the cause of it?

This problem has been studied by Prof. Eddington and several other noted astrophysicists with great care and they have reached the conclusion, that there is undoubtedly a limitation to the size of stars. The cause of this restriction lies in the energy of light rays. It was ascertained that the light rays from the sun produce a pressure of about two-thirds of a milligram on every square millimeter of the earth's surface. This pressure increases enormously with the temperature and when the latter, as it does in the large stars, reaches and often surpasses 100,000 and even a million degrees, the pressure becomes so great that it overcomes the resistance of the atomic structure of matter, causing its disruption. As the temperature of stars increases with their size, it is logical to draw the conclusion that there is a definite limit to the size of stars, which, according to Eddington, may be deter-

mined beforehand by calculations based upon careful observations.

WHAT DOES INTERSTELLAR SPACE CONTAIN?

Although for ages much has been thought, said and written about the problem which interstellar space presents to science, there is still a great diversity of opinions on the subject. Even the question of ether or no ether is still unsettled. As the problem is really of great importance for more than one reason, many distinguished physicists have made determined efforts during the last twenty years to find its solution. A definite conclusion has not yet been reached, but a great deal of highly surprising information has been collected, which has undoubtedly brought the problem much nearer to its solution.

It has been established beyond reasonable doubt, that the radiation pressure produced by the tremendous activity in the interior of the sun causes the ejection of a great volume of surface matter in a highly diffused state at all times. These minute particles of matter are expelled into space with a velocity of about 373 miles a second and, as their smallness greatly reduces the effect of the sun's mass attraction upon them, large masses of these particles get beyond the reach of the sun's power of attraction and continue their drifting through space.

While making a spectroscopic observation of some double stars, the noted astronomer Kapteyn made the discovery that part of the spectrum did not shift in accordance with the rotation of the two stars around the same axis, but held its position. The logical explanation was that that part of the spectrum was produced by some particles of matter which were diffused in space between the double star and the observer.

Lately Prof. Eddington has calculated the average speed with which the stars move through space and found it to be about 13 miles a second, which is about the same velocity with which our sun with its planets and their moons travel through space. From his findings and the average mass of the double stars referred to, which Kapteyn had determined, Eddington figured out the density the diffused matter filling space must have to make the average speed of the stars possible.

He found that the density was equal to 0.000,000,16 gram to 1 cubic centimeter of interstellar space. That would correspond with about 10 hydrogen atoms in each cubic centimeter.

Although, according to this calculation, the infinitesimally small particles of matter are only sparsely scattered in space, it has been calculated that a spherical section of space, with a diameter of about sixteen light years, would contain enough of them to form 128 stars, each equal in mass to our sun. Strange to say, cosmic space of that size does not as a rule contain more than 30 or 40 stars of the size of our sun. That means, in other words, that interstellar space, which has formerly been designated as completely empty, really contains about four times as much cosmic matter as the stars represent in more condensed form. It seems that the surprising result of these calculations should definitely settle the fate of the ancient theory of the emptiness of interstellar space.

WHY THE CENTER OF THE EARTH IS PROBABLY SOLID.

Although the earth had already reached a venerable age when the first human beings came into existence several million years ago, even the most progressive and intelligent members of the human race, until a comparatively short time ago, had only an extremely crude and rather phantastic idea about the interior of this planet. The hardness of the outer crust, the most terrifying phenomena of volcanic nature, like eruptions, earthquakes, etc., the existence of geysers, hot springs, solfataras, etc., were probably responsible for the introduction in many of the ancient and even more recent religions, like the Christian, of an imaginary subterranean region, the abode of the dead who were sent there by the supreme deity to suffer everlasting punishment for their misdeeds during life. These strongly rooted religious superstitions were probably one of the principal reasons for the tenacity with which the belief in a fiery interior of the earth was upheld until recently.

Even after the sciences had taken up the problem and had studied it for many years, no definite decision could be reached. Many conflicting theories were formed and each had its supporters among

scientists. Most of them seemed inclined to accept the theory that the crust of the earth is only 30 to 50 miles thick and that the whole interior of the earth consisted of mineral matter in a molten condition. To support their theory they pointed out that the heat produced by the gravity pressure of the mass of the earth must be enormous and far too intense to make it possible for the inner parts of the earth to be in a solid state. This argument, which for many years was recognized as incontrovertible, seems to be in danger of being disproved, which would naturally upset the whole theory.

The discovery, which tends to cause a complete revolution in our ideas about the condition of matter in the interior of the earth, was made recently during a series of experiments undertaken by Prof. Dr. Franz Simon, Director of the Physico-Chemical Institute of the University of Berlin, to study the effect of temperature on the liquefaction and solidification of various gases. The results of these experiments were decidedly unexpected and caused a startling sensation in scientific circles.

To explain the nature and meaning of the discovery, it is necessary first to make clear the meaning of the term "critical temperature." It means the highest degree of temperature at which a gas can be changed to liquid form, no matter how high the pressure to which it is subjected may be. Carbon dioxide, for example, becomes liquid at 0°C . under a pressure of 34.3 atmospheres, while at 31.9°C . 77 atmospheres are required to produce liquefaction. Above that temperature the gas resists liquefaction, no matter to what point the pressure may be increased. In other words, 31.9°C . is the critical temperature for carbon dioxide.

When Kamerlingh-Onnes at Leyden succeeded, in 1908, in liquefying Helium for the first time, it was found that the critical temperature of that rare gas was at -268° . Eighteen years later, Keesom succeeded in solidifying liquid Helium at temperatures ranging from -272° to -268.8°C . by pressures ranging from 25 to 140 atmospheres. Still later, Tamman and Bridgman succeeded in solidifying carbon dioxide at a temperature a few degrees above its critical temperature, by using a pressure of 12,000 atmospheres.

Quite recently, Dr. Franz Simon undertook an extensive and very thorough investigation of the problem, by studying the conditions under which a number of gases could be solidified. He found that Helium, with a critical temperature of -268° , could be solidified at a temperature of -253° under a pressure of 1000 atmospheres and even at the comparatively high temperature of -231° C., by increasing the pressure to 6000 atmospheres. It is estimated that even at ordinary room temperature, Helium could be solidified under a pressure of about 100,000 atmospheres. Tests with other gases, like Hydrogen, Nitrogen, Neon and others, gave similar convincing results.

These astonishing results throw a new and unexpected light upon the problem of the earth's interior. Formerly it was believed, that as the result of the high temperature in the interior of our planet no matter could exist there, except in a molten or gaseous form. The above mentioned experiments, however, make it seem rather doubtful that, even at the high temperature probably prevailing in the central portions of the earth, any matter could remain in a liquid or gaseous state under the tremendous pressure existing there, which is estimated at approximately two million atmospheres.

Several scientists have pointed to the fact that earthquake vibrations are transmitted through the central portions of the earth with surprising distinctness, as strongly supporting the theory that the interior of our planet is not liquid or gaseous, but solid.

HOW OLD ARE METEORITES?

The time element has always been a very uncertain quantity in all branches of cosmology. Before geology had developed to a comparatively high stage, it was even impossible to find a basis for estimating the age of the earth, excepting religious traditions. In more recent times, scientists used various methods and bases for estimating the duration of geological periods and of the age of our planet, but the different methods almost invariably led to conflicting results, which merely increased the uncertainty of the estimates.

The situation became greatly changed for the better after the discovery of Radium, which led to a surprisingly rapid growth of our understanding of radio-

activity, its nature, its effects and the conclusions that may be drawn from them. It was learned that Radium, the remarkable new element, discovered by Madame Curie, was but one of a group of elements all of which possessed more or less radio-activity and that all the elements of that group were really related to each other. It also was found that the two metals, Uranium and Thorium, headed the list of radio-active elements and that the other members of that group really represented various decomposition stages of these elements.

After a great deal of intricate study, experimentation and calculation, the conclusion was reached that the various stages of disintegration from Uranium to the final product, Radium G or Actinium D, each an isotope of lead, and from Thorium to Thorium D, also an isotope of lead, develop spontaneously, but invariably in accordance with definite laws and that the process of disintegration is accompanied by the emission of three kinds of rays, designated as alpha, beta and gamma rays.

It was further ascertained, that the alpha rays consist of Helium nuclei, the beta rays of electrons and the gamma rays are really Roentgen rays of extremely short wavelength. After the alpha particles have lost their initial velocity, they take up electrons and thus become Helium atoms.

By complicated calculations it has been ascertained, that to convert one percent of a given quantity of Uranium into Radium G, an isotope of lead, almost 100,000,000 years are required. It was also ascertained, that one gram of Uranium sends out 97,000 Helium atoms every second or about 2.8 billions a year. To produce, at that rate, one cubic centimeter of Helium would require about nine million years.

With the aid of the new method it became possible by carefully examining specimens of minerals containing Uranium and ascertaining the quantitative proportion between the remaining Uranium and the lead isotope or the Helium accompanying it, to estimate the age of the earth at approximately 1600 million years.

The same methods applied to meteorites, in which occasionally small quantities of

Uranium together with lead isotope or Helium are found, led to results which strongly indicate that the meteorites examined belonged to our solar system and not to some other solar system at a great distance from ours. The age of most of them varied between 16,000,000 and 1,000,000,000 years, which does not exceed the age of our sun and its planetary system.

ANOTHER GLACIAL PERIOD?

The remarkable progress in nearly all the different sciences during the past hundred years has created the impression, not only among the ignorant masses, but even among those possessing a fairly good education, that in another hundred years, or perhaps in two hundred, the human race would know practically everything worth knowing, at least about the earth and everything on or in it. Unfortunately, that impression is entirely wrong and unjustified. True scientists and thinkers fully realize that the prospects of finding a solution of all problems in nature are so obviously chimerical that it is really absurd even to think of their possibility.

A single example will be sufficient to explain the reason for this attitude of the men of science. Let us suppose that somewhere, in the central part of one of the large continents, many hundreds of miles from any large body of salt water, the fossil remains of some animal organism are found embedded in a rock formation of Neptunic origin. The natural inference is, that at the time when the animal was alive it lived in the sea. If no other fossil of the same kind had ever been found, it is classified and named. But is that all?—By no means!—If the animal was a sea inhabitant, there must have been a body of salt water where its fossil remains were found. But what became of that sea or part of the sea? Why did it disappear? When did that change take place? Was it sudden or slow? What was the cause of the change?—And so on ad infinitum.

The finding of the fossil established one fact—that the animal had at one time in the remote past existed—but at the same time its finding involved a large number of new problems, many of which may never be solved, not even theoretically. Practically every new find or dis-

covery in the field of the natural sciences does the same thing. It answers one question and, at the same time, presents countless new problems, each of which may involve a host of other new problems.

These introductory remarks should enable the reader to understand more readily the difficulties with which geology has to contend when it attempts to solve the problems invariably connected with every new discovery or find.

One of the most puzzling problems is offered by the Glacial Age, a period through which the Earth passed during the Pleistocene. It is, of course, not impossible that our planet during the many millions of years of its existence had passed through other glacial ages before the beginning of the Pleistocene, but no direct evidence of it has been discovered so far. That the earth has undergone many material atmospheric and climatic changes, is undoubtedly true, but the Glacial Age during the Pleistocene was the only period of that nature known to us. What we know about it is of a rather vague nature as to time, duration, cause, etc., but we have reason to believe that both the American and the European continents were involved in the peculiar climatic changes which during a certain period caused the ice caps of the continental glaciers to extend until they covered a considerable area of North America and Europe and then to recede during warm intervals, until another icy period caused another extension of the ice caps. This extension and recession, it is believed by some authorities, was repeated six times on the American continent and four times in Europe and the last recession took place probably 40,000 years ago.

What caused the peculiar conditions which undoubtedly existed on this planet during the Ice Age and during the interglacial periods is not known to us and may never be explained. Nor has it been possible so far to answer the question whether the Ice Age was merely a phase in the history of our planet, due to a peculiar combination of circumstance that may never happen again, or whether a repetition, or even periodic repetitions of that phase may be expected. If the latter supposition should be correct, the question would naturally arise, in how many years from now will the next glacial period begin, how long will it last and what will

be the duration of the next inter-glacial period?

That brings us to another puzzling problem. Are we justified in believing that the recession of the glaciers, which began approximately 40,000 years ago, meant the final phase of the Ice Age?—Or does the present period merely mean another inter-glacial phase, like the several previous ones which interrupted the Ice Age on this continent? In other words—is the Ice Age a thing of the past, perhaps never to return, or are we now merely living in another inter-glacial period which, sooner or later, will be followed by another glacial period?

It is not surprising that the opinions of the geologists who have ventured to answer at least some of these questions are by no means unanimous. The theories differ widely and all of them suffer from the lack of positive and basic knowledge of facts, which alone could form the foundation for a reasonable and convincing theory.

One of the noted geologists, Robert W. Sayles, of Harvard University, is evidently of the opinion that our planet has not yet completed its Ice Age experiences, but is now merely in one of the inter-glacial periods, which may be followed by another or many other glacial periods. If that should be the case, it would be very likely that once more, or even oftener, the northern part of this continent would be overwhelmed with a covering of ice that would destroy all animal- and plant-life and all evidence of human civilization.

Of course, there is really no tangible evidence to prove the correctness of this theory or even to support its probability. But, even if it should be correct, it would be impossible to predict with any degree of certainty when the next period of glaciation would begin and how long it would last. The principal reason for the impossibility of establishing any logically founded theory at the present time lies in the fact that we are still ignorant of the exact reasons which caused the Ice Age or, at least that part of it which has already passed.

IMPORTANT FIND IN NEW MEXICO.

During the past year a very interesting and important palaeontological find was

made in a cave on Bishop's Cap Peak, near Mesquite, N. M. The discovery was made accidentally, while Roscoe P. Conkling, an El Paso mining man and amateur archaeologist, was exploring that cave in the hope of finding a treasure which, according to tradition, the Spaniards had buried there centuries ago.

While digging in that cave and having reached a depth of ten feet, Conkling found—not the expected Spanish treasure—but a layer of animal bones and a human skull. He informed Dr. Wm. Alanson Bryan, director of the Los Angeles Museum of Natural History, of the find and Dr. Bryan promptly hastened to New Mexico to inspect the collection of bones. After he had carefully examined them, he bought the lot of fossil remains from Conkling for \$1,000 and shipped them to Los Angeles, where they are now on exhibition in the Museum.

Since then the excavations were continued under the direction and supervision of J. W. Lytle, assistant palaeontologist of the Los Angeles Museum. In addition to the animal bones and the human skull exhumed by Conkling, other animal remains, including an almost complete skeleton of a ground sloth, leg bones of a very large camel and numerous bones of cave bears were found before a depth of thirty feet had been reached. About ten feet below the human skull found by Conkling, another human skull was discovered.

Dr. Gryan has expressed the conviction that the finding of the two human skulls together with the fossil bones of animals, extinct, at least on this continent, since the Pleistocene period, would establish the fact that human beings existed in America as far back as the close of the Pleistocene period, possibly 250,000 years ago.

Other geologists, however, do not agree with Dr. Bryan and point out that the fact that a human skull was found in close proximity to the buried bones of some animals does by no means prove that the human, whose skull was found, was living at the same time as the animals near the remains of which his skull was found. This objection is undoubtedly justified, as, in many cases, more conclusive evidence than the mere finding of human and animal bones together is necessary to prove their contemporariness. Yet, Dr. Bryan may be right.

WONDERFUL FOSSIL-FIND IN MONGOLIA

Only a few months ago, the exploring expedition headed by Roy Chapman Andrews discovered on the shores of a dried-up inland sea near the Mongolian border one of the most remarkable fossil deposits ever found within a rather limited area. The find consisted of the complete skeletons of about 25 or 30 shovel-jawed mastodons (*Platybelodon*) of different ages, which had lived in Mongolia about three million years ago.

Along the shore line of that former sea a number of pits were found, all of them filled with the remain of *Platybelodons*. While roaming along the shore, these animals, young and old, came to grief by getting trapped in these pits which were filled with sand and soft mud and swallowed the heavy bodies of the animals which sank and suffocated in the soft mud.

Although only a comparatively small

number of skeletons has been dug out so far, it is expected that the total find will consist of at least thirty complete skeletons of *Platybelodons* from the newly born to the old. While one of the pits seems to contain mostly skeletons of fully matured animals, another pit was filled with the remains of very young animals.

This find is of great importance, because it is the first time that any complete skeleton of *Platybelodons* has ever been discovered. Near the same locality a single jaw, between five and six feet long, which came from one of these animals, was found in 1928 and this led the explorers to continue their search, which was finally crowned with wonderful success.

The expedition plans to continue its work along the shore line, in the hope that the skeleton of a primitive man, even older than the *Peiping Man*, may be found, who had been similarly trapped in one of the mud pits.—*E. Welleck*.

"HE'S A BRICK"

Plutarch, in his life of Lycurgus, is authority for the quaint expression, "He's a Brick." The Spartans, or Lacedaemonians had a force or poignancy of expression which cut down all the flower of studied elegance. They were trained to speak concisely, and encouraged in repartee. Our English word laconic is derived from the Lacones or Spartans, and implies that much is expressed in few words. Lycurgus himself was short and sententious in his discourse. When asked why he had made so few laws he answered, "To men of few words few laws are sufficient." When asked how they could best guard against the invasion of an enemy he replied, "By continuing poor"; and to the question, whether they should enclose Sparta with walls, "That city is well fortified, which has a wall of men instead of brick." This is probably the foundation for the story that on a

certain occasion an ambassador from Epirus on a diplomatic mission, was shown by the king of Sparta over his capital. The ambassador, knowing that though nominally only king of Sparta, he was yet ruler of Greece, looked to see massive walls for the defense of the towns, but found none. He marveled much, and at last said to the king, "Sire, I have visited most of the towns but found no walls built for their defense. Why is this?" "Indeed!" replied the king, "Thou canst not have looked carefully! Come with me tomorrow, and I will show you the walls of Sparta." On the following morning the king led his guest out upon the plains where his army was drawn up in battle array, and pointing proudly to the serried host, he said, "There thou beholdest the walls of Sparta, and every man a brick!"

EARTH'S CORE STIFF AS IRON

See also Vol. III, pp. 108-109.

Earthquakes have literally shaken off the old theory that the earth's hot interior is a mass of liquid lava. The rate at which these disturbing waves travel through the globe indicates that our planet is a great lump of iron covered with several platings of stone.

These and other scientific facts about the interior of the earth were discussed by Prof. Kirtley Mather of Harvard University, in a radio talk arranged by *Science Service* for the Columbia Broadcasting System.

Prof. Mather said, in part:

"The velocity at which the earthquake vibrations move through earth material is determined by the elasticity and density of the material encountered and by nature of the vibration itself. In general, it takes about 25 minutes for the swiftest earthquake waves to travel by the most direct route, from the point near the surface at which they originate to a point on the surface directly opposite on the other side of the globe. This route is of course through the center of the earth and is therefore about 8,000 miles long. This is about the rate at which such waves travel through glass or steel, and it indicates that the earth as a whole behaves as though it were composed of material as elastic and dense as would be a sphere of glass or highly tempered steel of its dimensions. No great ball of molten rock with a thin crust of frozen surface material could possibly behave as does the earth. The earthquake messages tell us unmistakably that the earth is much more solid than it

used to be considered. Its interior may be very hot but it cannot be essentially liquid.

"But earthquake velocities vary from place to place within the earth. In general the deeper the path, the swifter the movement. This is largely due to the increase in density with depth. Each cubic mile of rock is under pressure equal to the weight of a column of rock one mile square and as high as the distance out to the surface. Such a column a thousand miles high puts tremendous pressure upon the rocks at a depth of a thousand miles. In consequence the rock at that point is compressed so that it transmits vibrations much more rapidly than it would do were it at the surface.

"However, whereas pressure must increase rather regularly from surface to center the travel rate of earthquake waves changes irregularly with depth. In fact, as these waves approach the center and pass through the material at great depths they are quite abruptly slowed down from velocities of eight or nine miles per second to velocities of only five or six miles per second. The only possible explanation of this fact is that the material there must be very different from that nearer the surface. In all probability, the central core of the earth is composed not of rock with high elasticity, but of a metal like iron which is far less elastic. Judging from the composition meteorites, which presumably are samples of the stuff of which planets are composed, the earth's core is a mass of mixed iron and nickel."—*Science Service*.

THE EARTH AND ITS ORGANIC LIFE

The past year has been unusually prolific in important discoveries concerning, not only the geological structure and history of our planet, but also the evolution of organic life upon it, including that of the human race. During the last fifty years the progress in geology, palaeontology, anthropology and related sciences has been quite remarkable, due, to some extent, to accidental discoveries, but principally as the result of the strenuous and well directed efforts of a number of exploring expeditions composed of competent and active scientists, which had been sent to various parts of the world for the purpose of thorough investigation.

Unfortunately, many of these new discoveries, although their importance is fully recognized, do not always supply conclusive evidence to prove or to disprove any of the theories, more or less generally accepted, by which science seeks to explain and systematize the structure, evolution and other facts concerning nature from the meager and decidedly fragmentary evidence gathered.

THE ORIGIN OF MAN

When, where and how did man originate? That question has been an intensely interesting and decidedly puzzling problem to thinking minds for many thousands of years. Ancient scientists and philosophers, hundreds of years before the birth of Christ, gave a great deal of thought to that question, but could not find a logical and satisfactory answer, although many of them found it impossible to accept as true the phantastic explanations offered by religious traditions.

The Bible, which has been accepted by the Christians as the fundamental document and record of their religion, presents the "history of creation" in a simple and picturesque form, yet so vaguely worded, that it led to many conflicting interpretations even among the noted Christian scholars. As laid down in the Bible, the "history of creation" represents undoubtedly a modified and much simpler version of a mixture of ideas of ancient Hebrew and Chaldean origin, the incongruity of which was evidently not recognized by the compilers of the "Old Testament."

Since then the knowledge and under-

standing of the human race has made great progress. Sciences, formerly not even thought of, have sprung into existence, means and methods were developed which made it possible to make observations and, through the collaboration of the various sciences it became possible to reach an insight into the methods and laws of nature, heretofore absolutely impossible.

Although now the intelligent and educated classes of all races and nations of higher advancement in cultural development have practically abandoned belief in the "history of creation" as presented in the Bible, the problem of creation and of the origin of man is still unsolved. There are many reasons for doubting the picturesque account of the individual creation of Adam and Eve as the first human beings, from whom all other human beings became descended, but the question, when, where and how the human race originated, still remains unanswered.

Let us first consider the time feature of the problem. Science has reached the conclusion long ago that the human race must have sprung into existence more than a few thousand years ago, as had been the belief of our ancestors. It is now generally accepted by science that the human race has been in existence more than one million years, but—how much longer is not known. Some scientists are inclined to believe that the origin of man in its most primitive form may date back possibly more than two million years.

As to the second part of the question, where man originated, the opinions of men of science differ even more than in regard to the first part. While some scientists believe that man originated somewhere in Europe, others are of the opinion that the human race sprang into existence in some part of Asia and still others are equally convinced that Africa was the cradle of the first human beings. That leaves only the American continent and Australia free from suspicion of having witnessed the origin of man and Ameghio the Argentine believed even America was the place of origin. The belief in the statement of the Bible, that man originated in Mesopotamia, the supposed location of the Garden of Eden, has been practically aban-

done by science for many convincing reasons.

The diversity of opinions as to how man originated is practically limited to two views, which really differ only in one respect. One side, which includes practically all prominent anthropogenists and anthropologists in the world, adheres to the opinion that the human race developed gradually, through variation, from some branch of the anthropoid apes, perhaps several million years ago; and during that time by slow degrees developed from the primitive, apelike type to its present highly advanced type of *Homo sapiens*. The other side, which is represented in the United States by Dr. Henry Fairfield Osborn, President of the American Museum of Natural History, does not agree with that theory, but maintains that the *Hominidae*, or, in other words the human race, had never had any direct relationship with the apes, but that each represented an independent type of development which had emerged from some primitive anthropoid stock probably several million years ago. It seems, however, that granting the correctness of Dr. Osborn's theory, it would not remove the relationship between man and ape entirely, but would merely make them more distant relatives.

THE SKULL OF THE "PEKING MAN"

What is generally considered the most important discovery of the past year in the fields of anthropology and ethnology was the finding in a cave near Peiping, China, the skull of the "Peking Man," known to scientists as *Sinanthropus Pekinensis*. The remarkably well preserved skull was dug up on December 2nd, 1929, at Chow-Kow-tien, about thirty miles from Peiping, by W. C. Pei, a young Chinese student, connected with the exploring party at work in that locality. Together with it a number of human and animal bones were found, but no tools and no evidence that any fire had been used by any human beings who may have lived in that cavern. The scientists who had an opportunity to examine the skull and who were acquainted with the geology of the locality where it has been found, were inclined to believe that the skull dates probably from the lower Pleistocene epoch, approximately one million years ago.

It is the opinion of the noted scientists

who have had an opportunity to examine it, that it belonged to a type, distinctly different from that of the Trinil man of Java, the Heidelberg man, the Piltdown man of Sussex, England, or the Neanderthal man of Prussia, although there is a similarity of some of its characteristics with corresponding characteristics shown by some of the other skulls, particularly those of the Trinil man, the Heidelberg man and the Piltdown man. Some of the most striking features of the *Sinanthropus* skull seem to be its exceptionally large volume, its rather slender lower jaw and the greater height of the skull vault.

Dr. Davidson Black, a noted Canadian anatomist, connected with the research expedition which led to the find, after a careful examination of the *Sinanthropus* expressed the firm belief, that the interesting skull is not that of a man, but of a woman, apparently of a young female adult.

THE "SPRINGBOCK" MAN

Africa has in recent years supplied a number of interesting finds of fossil anthropoid and human remains, dating from various periods between the latter part of the Tertiary and the post-glacial period. The most important of these finds were the anthropoid skull of Taung, near Mafeking, the skull of the Rhodesia man of Broken Hill, the skull of Boskop and the skeleton of Oldoway. Another important find has been added to the list, the fragments of the skull and parts of the skeleton of an apparently mature man, which, together with other bones, including those of a gigantic buffalo, were found in the Springbock Flats in the northern part of the Transvaal. The buffalo and also the human remains are believed to have been contemporaneous toward the end of the Pliocene or the beginning of the Pleistocene epoch.

As reconstructed, the skull showed a length of 195 millimeters and a width of about 144 millimeters and indicated an unusually large brain capacity. The forehead rises steeply, and has but moderately developed orbital ridges. The chin is moderately well formed and the bones of the lower jaw are massive and strong.

The Springbock man, in the opinion of the scientists, was surely not a negro and it is believed that he belonged to an early branch of the Hamitic race which is sup-

posed to have originated in northern Africa and to have been closely related to the European Cro-Magnon race.

ABOUT THE PYGMIES OF NEW GUINEA

In an address which Mr. Matthew Sterling delivered before the American Association for the Advancement of Science, he conveyed much highly interesting information concerning the Pygmy race in New Guinea, which had been almost unknown until Mr. Sterling, chief of the Bureau of Ethnology of the Smithsonian Institution at Washington, D. C., led an expedition to their haunts in the almost impenetrable interior of New Guinea in 1925.

The explorer stated that careful study of all the information he had been able to collect from all available sources and his own observation had led him to believe that the pygmy race originated in tropical Africa at a very remote period and that at one time they probably lived in great number not only in the interior of that continent, but also along the coasts and river lines.

He expressed the belief that the great bulk of the pygmies was driven from Africa about 15,000 years ago, probably by the Bantu people, a large and powerful negro group. The pygmies moved eastward until they reached the southern coast of Asia, along the Indian Ocean. At last they reached the Malay peninsula, from which point one part of them continued eastward through the islands of the East Indies, while the rest followed the eastern coast of Asia and the adjacent islands until they reached Japan.

Being small and naturally peaceable, the pygmies were unable to hold their own against other more powerful races which invaded the islands and the territories in Asia where the pygmies had found a refuge. These migrations, which eventually drove the pygmies from their new homes in Asia, consisted of an early Caucasian invasion emanating probably from the region near the Caspian Sea, a Mongolian invasion from the North and the expansion of the Malay people.

First the pygmies were driven away from the seacoast and finally from the less habitable interior valleys until they were forced to seek refuge in the rugged mountainous regions. The regions in which survivors of their race may still be

found are in the interior of Africa near the Upper Congo, in Ceylon, in the Andaman Islands in the Bay of Bengal, in the Malay Peninsula, the Philippines and New Guinea. Their life, wherever they are, is extremely simple and primitive, practically under Stone Age conditions. Mr. Sterling estimates the number of pygmies still living in New Guinea at between 20,000 and 100,000, while their total number in Africa is even less.

THE MYSTERY OF ATLANTIS

Among the ancient Greeks and other equally old or even older nations in Europe and Africa a tradition existed, that once upon a time there was a large island continent, known as Atlantis in the ocean west of Africa, which was inhabited by a highly civilized race of white people who spoke and wrote a language entirely different from that of other nations living at that time. According to the same tradition the entire tribe or race of the island realm perished one day, a long time ago, when the islands of which it consisted were suddenly swallowed by the sea.

This tradition was in ancient times undoubtedly accepted as a fact and was accounted for as an act of punishment by the gods for certain acts of the islanders by which they had offended the heavenly powers. In the course of time this formerly accepted fact became a mere myth, yet many of the religious people still believed in it.

When Spain took possession of the Canary Islands many centuries ago, its representative, Alonzo Fernandez de Lugo, found that Teneriffa, the largest of the islands, was divided into nine kingdoms, each governed by one of the sons of Tinerife the Great, the last great king, who had ruled the whole island up to the time of his death. The nine sons and their loyal subjects vigorously resisted the Spanish invaders, but were overpowered and greatly reduced in number. Although the Spaniards retained possession and control of Teneriffa and the other islands of the Canary group, the Guanches, as the inhabitants of these islands were called, kept aloof from the invaders and remained hostile to them. The constant warfare and epidemics probably resulting from it, finally brought about the extinction of the natives.

Shortly after the Spaniards had taken possession of the Canary Islands and while many of the Guanches were still living, Frater Alonzo Espinosa, a Dominican monk from Spain, visited the islands and collected from the natives all the information obtainable about their history, myths and traditions. As the Guanches were a primitive people and could neither read nor write they could only repeat what had been transmitted to them orally from generation to generation.

Not until recently did the data which Frater Espinosa had collected from the Guanches and written down, receive the attention from the scientific world, which they deserved, as they seem to throw considerable light on the mystery surrounding the original inhabitants of Teneriffa and the other Canary Islands before the invasion of the Guanches.

Espinosa learned, that the Guanches came originally from Icod, a country not yet identified and reached Acinech, now known as Teneriffa, about 1500 years before the Spaniards took possession of it and the other islands of the Canaries. When the Guanches reached Teneriffa, they found it inhabited by a race of white and powerfully built people with regular features and a comparatively high degree of intellectual development. They called the principal island Nivaria, were politically well organized, had and practiced a system of writing, possessed artistic ability and had a knowledge of surgery, mummifying and other arts.

The original population of Teneriffa, which was apparently peacefully conquered by the Guanches and gradually became amalgamated with them, was divided into three classes: the Archimenceyes, to which only the members of the royal family belonged, the Chichiciquitso or the aristocrats, and the Achicaxnas, or common people. They had neither priesthood nor religious ceremonies, but believed in the existence of three gods, named Achguayaxeraz, Achoron and Achaman and of an evil spirit, named Guayoto.

It is now believed by a number of scientists who had an opportunity to examine a number of skulls of bodies dating from the earliest period of the Guanches invasion, that the original inhabitants of the islands were probably the remaining mem-

bers of the Atlantis type who had found refuge on some of the Canary islands, when the large Atlantis landmass was swallowed by the sea. Careful measurements of the skulls of these last remainders of the Atlantis people strongly indicate that they were descendants of the Cro-Magnon type of man. A careful and extensive research has recently been undertaken, to verify the facts already obtained and to find additional material that may lead to startlingly interesting and important new conclusions.

TWO INTERESTING FOSSIL FINDS

The largest specimen of a fossil hog, known to science as *Dinohyus hollandi*, was found within the past year in Sioux County, Neb., and its mounted, well preserved skeleton is now exhibited in Morrell Hall at the University of Nebraska. Only one other specimen of that species has ever been found and that is smaller than the one exhibited at the University, which is fully seven feet high. These hogs lived toward the latter part of the Oligocene, or in the early part of the Miocene epoch of the Tertiary period, approximately twelve million years ago.

Another, even more remarkable find of a fossil vertebrate, also from the Oligocene, was discovered by an exploring party of the South Dakota State School of Mines in the Lower Oreodon beds of Cain Creek, about two miles north of Imlay in the heart of the Big Badlands of South Dakota. It consisted of the remarkably well preserved fossilized skeleton of a female Oreodon (*Merycoidodon culbertsoni*) with unborn twins. This was the first time that a fossil mammal has been found, together with its unborn young.

The skeletons of the young animals were not as well preserved as the skeleton of their mother. That is easily understood, as the skeletons of the unborn young, being of a more cartilaginous than osseous character, possess less power of resistance than the bones of mature animals and do not become fossilized as easily. Only the skulls and some of the larger leg bones are fairly well preserved. Both skulls showed well developed teeth. The interesting specimen is now on exhibition in the geological museum of the School of Mines.

A PETRIFIED FOREST DISCOVERED IN MONTANA

The Bureau of Reclamation recently reported, that H. A. Parker, superintendent of the Lower Yellowstone project, Montana-North Dakota, and E. E. Roddis, district counsel, at Billings, Mont., had discovered a remarkably interesting petrified forest on Indian Coulee, about three miles southwest of Savage, Mont. The forest, which covers several acres west of the road from Glendive, Mont., to Williston, N. D., which is now being reconstructed with federal aid by the State of Montana, contains a large number of fos-

silized trees, some of them ten feet in diameter and over one hundred feet long. The tops of the trees taper off abruptly, which suggests the theory that they belonged to the same species as some of the carbonized trees found in the coal deposits of the same geological period. From the fact that all the trees found in that area point with their tops in the same direction, it is inferred that they were all blown down by a violent southeast wind. For some reason the silicate deposit which petrified the trees did not crystallize, so that the growth rings can not be distinguished.—*Ernest Welleck.*

THE LATIN LANGUAGE

The Latin language first appears in literature as the language written, as well as spoken, in the plain of Latium, in the third century B. C. But the conquering armies of Rome soon carried a knowledge of the Romas or Latin tongue to the utmost boundaries of the known world, and the Latin language either took the place of the native language of every conquered nation, or else became engrafted upon it. Hence its presence is discernible in all European languages. Those languages which are the immediate offspring of the Latin, as the Italian, Spanish, Portuguese, and French, both Norman and Provençal, are called the Romance languages. Wallachian, the language of Roumania, in which Latin predominates, has not until lately been classed with the Romance languages. M. Littré says: 'Latin alters, without doubt, toward the end of the empire and after the arrival of the barbarians, and the style of Gregory of Tours is very far removed from the purity of Livy; but after all it is Latin, and not one of the Neo-Latin languages. Then all at once it disappears, and we see arising, as if from under the ground, the various idioms to which it has given birth. It dies suddenly and without transformation, so that these secondary languages cannot be considered as the metamorphosis or expansion of it. We have no right to say that Latin is continued in new languages; it died without developing itself, but died leaving children and heirs.' Latin ceased to be a spoken language 580 A.D.; but it remained the organ of gen-

eral literature until the early part of the seventeenth century, twelve centuries after the dissolution of the Roman Empire. The last great philosopher who habitually wrote his works in Latin was Leibnitz (1646-1716). In the eighteenth century we still find Latin used for works on science and philosophy, and in 1760 Linnaeus issued his famous work on botany in Latin. The earliest work of Agassiz, born 1807, was in Latin. The general use of Latin in diplomacy, or for the formal intercourse of nations, was continued in the seventeenth century; but it was as late as 1825 that Latin was for the first time displaced by the Magyar or native language of Hungary in the debates of the Diet of that country, Joseph II having in vain attempted to make German the official language of Hungary in place of Latin. It is now the universal custom that written communications from foreign powers shall be made in the vernacular of the country from which they come, but, with rare exceptions, oral intercourse is carried on in the French language. It is interesting to note that Dante's *Divina Commedia*, the first great work in the Italian language, can still be understood by uneducated Italians, while, on the other hand, Chaucer, who a century later was the first to write in the English language, requires an interpreter. Milton wrote as lately as 1650 his "Defensio pro Populo Anglicano" (a defense of the English people for beheading Charles II) in Latin, although his immortal works were written in modern English.

THE NATURE OF MATTER

As far as we know at the present time, our material earth is composed of only about 90 elemental substances. They can be combined with each other, however, in different proportions and in various forms so as to compose several hundred thousand more complex substances which have been identified in nature or synthesized in the laboratory. Our knowledge of matter in other worlds as brought to us in meteorites, or even in other galaxies as we study the rays of the stars, indicates that the entire universe is composed of the same elements.

If we could communicate by radio with other planets, some of which must be inhabited by intelligent beings, one of the most tangible criteria of their stages of development in cultural life would be the degree of knowledge of their material world. Doubtless some would exhibit more primitive, others more advanced states of knowledge than our own.

Judging from our own experience, the curve of progress would always show a marked induction period—very long periods of time in the beginning to attain a certain state of progress—always shortening of the period or acceleration of the progress in each new advance.

From the rough to the polished stone age might be measured in hundreds of thousands of years, to the bronze age a few ten thousands, to the iron age perhaps ten thousands, to steel a thousand, to the modern Bessemer furnaces less than a hundred, to the electric furnace fifty, to the induction furnace 10-20 years more, and so forth,—each discovery hastening the next by making it easier.

In spectroscopy when lines fall successively closer and closer together, we say we have a converging series, and reach at the series limit a critical condition where something unusual happens. The atom or molecule breaks down. The rapid material progress of today has made some people wonder if we are not approaching such a breaking limit. Dr. Millikan in a lecture referred to the view of the Bishop of Ripon who has called on scientists to cease activities for 10 years to give the world time to catch its breath.

But it is not my purpose to discuss the effects of the rapid development of science in recent times, but rather to point out that every period of rapid development always has its specific causes. It will be impossible in the time at our disposal to do more than select a few isolated instances.

The modern science of chemistry began with the discovery of oxygen by Priestley in 1775 and the overthrow of the phlogiston theory. The controlling cause was the discovery of *gases*. Perhaps this is an exaggeration, for surely air had been known from the beginning. But the failure to recognize air as a ponderable mixture of gaseous elements had led to a singular confusion of ideas which permitted the false concept of phlogiston to dominate alchemy during the middle ages. Before the discovery of oxygen it was evidently impossible to get a correct conception of oxidation and reduction processes—hence the winning of metals by metallurgical reduction was confused with transmutation of elements, always the unattainable goal of alchemy. Based on the work of Priestley, Black and Cavendish, the brilliant young French chemist Lavoisier, who lost his life in the French Revolution, brought order out of confusion and founded the present principles of chemistry as a quantitative science.

The application of electricity to chemical investigation by Sir Humphrey Davy, ushered in another era of discovery by enabling the separation by electrolysis of some very basic metals from their oxides which had previously been thought to be the elements themselves. A little later his distinguished pupil, Michael Faraday, took a great forward step in the disclosure of the relation of matter and electricity as embodied in the law known by his name, which states that in electrolysis one unit of electrical charge is associated with one chemical unit of matter, indicating a very fundamental relation between electricity and matter.

One hundred years after Priestley discovered oxygen, America made her first contribution of the first magnitude to physical chemistry, and in a very singular and non-spectacular manner. Josiah Wil-

lard Gibbs, a professor at Yale College, so retiring that we are assured he was almost unknown to his younger colleagues, worked alone and unheralded, without equipment or laboratory, in the application of thermodynamics to systems of chemical and physical equilibrium. He left behind at Yale little immediate trace of his ever having been there. He founded no school of thermodynamics and had no followers. His publications made in an obscure journal remained unknown for 25 years until two European chemists found them and brought them to light. Since that time the work of Gibbs has continued to dazzle the scientific world by its brilliance and profundity. He created a new tool, introducing an era of progress in heterogeneous equilibria by the application of Gibbs' famous phase rule—which, by the way, was only one of his many important contributions. Today phase rule diagrams are used in every plant in the world where steel or any other metallic alloy is made, wherever salts are separated from solutions or from each other. Even the great chemist Van t' Hoff spent his entire last years in Berlin, employing Gibbs' phase rule to unravel the mysteries of the great natural Stassfurt salt deposits in Germany.

In 1894 Ramsay and Rayleigh discovered argon in the atmosphere. It had previously escaped observation on account of its chemical inertness. Following the property of inertness and using the methods of fractional distillation, Ramsay quickly brought to light the rare elements in air,—helium, neon, krypton and xenon, thus completing the work begun by Priestley 120 years before. Today we have helium-filled air ships, argon-filled electric lamps, and neon-filled electric advertisement tubes.

In 1896-8 the most startling discovery was made in chemistry since the discovery of oxygen, namely that many of the heavy elements are not stable—but decompose spontaneously, with emission of energy, into lighter elements and helium. This is, of course, the property which we call *radioactivity*. Its discovery and early development is associated with the names of Becquerel, Pierre and Marie Curie, Rutherford, and Soddy. Its investigation quickly gave us 35 or 40 new elements, which have not only been successfully fitted into the Periodic System but have given to it

a new importance and a genetic law bringing the radioactive elements into conformity with all its previously known principles and thus establishing a law of evolution in inanimate matter.

In order to bring all of the forty radioactive elements into the twelve available places in the periodic system, it was necessary to put more than one element into the same place. Soddy therefore called them *isotopes*. Their identity in all chemical and most physical properties was previously known from the failure of Boltwood to separate thorium from ionium and of Soddy and others to separate radium from mesothorium. This new principle of isotopism led Thompson and Aston to seek isotopes or new species of elements among the ordinary non-radioactive elements. They separated and weighed the species differing from each other only in mass—not in a gravity field but in balanced electrical and magnetic fields. This method so far has disclosed that more than half of the sixty or more elements that have been examined are composed of two or more isotopic species, some of as many as eleven.

Quite recently a still more refined method of weighing isotopes has been discovered, namely, by means of the vibrational band spectrum of some compound of the element in question. By this means it is found that oxygen in the atmosphere is composed not of O^{16} atoms alone but of 1 part in 650 of O^{18} and of 1 part in 10,000 of O^{17} atoms. A few years ago it was a question whether isotopes of the same element would exhibit any spectral differences. Only the most delicate interference methods then available disclosed them. Today such differences are being used to discover new isotopes.

Besides the different *atomic* species of many of the elements, a new type of kinetic isomerism in *molecules* was predicted by Dennison in 1927. In 1928 Giauque and Johnston partially confirmed the prediction in the case of the hydrogen molecule and in 1929 Bonhoeffer and Harteck gave a complete confirmation of the theory and prepared para-hydrogen practically free from the ortho form. They found that ordinary hydrogen is composed of about 75 per cent of one and 25 per cent of the other form. It is not improbable that similar isomeric forms of

other molecules will be discovered in the near future.

Rutherford first found that when gaseous nitrogen is bombarded by alpha particles from radioactive material that very rarely one strikes the nitrogen nucleus so directly that a swift proton is ejected. By using a moving picture camera to photograph the fog tracks of the particles in nitrogen it was found by several observers that the alpha particle which is a helium nucleus sticks in the nitrogen nucleus when expelling a proton. The resulting nucleus should have three more units of atomic mass and one more unit of positive charge. It is therefore no longer an atom of nitrogen but an isotope of oxygen of mass 17 instead of the usual 16. We may express the reaction as:



Since O^{17} , as we have seen, has been found in the earth's atmosphere to the extent of 1 part in 10,000 of the O^{16} atoms, it is interesting to calculate from the known amount of radium emanation (gas) in air (10^{-10} curies per cubic meter) whether its alpha radiation could within a reasonable geological period have generated the amount of O^{17} which we find now in air.

The result is 10^{14} years, a period much longer than we can allow. It seems, therefore, if O^{17} was ever generated at all by this process, that it was mostly not in our atmosphere, but either elsewhere in the universe and came to earth as primordial gas, or else it has been generated in the earth's crust and reached the atmosphere by diffusion. It would lead too far to discuss the latter possibility.

From having had 90 elements we are now reduced to two, the electron and the proton—even fewer than the five which the ancients had. The electron is the atom of negative electricity, and the proton the nucleus of the hydrogen atom and apparently the atom of positive electricity. Even these two may mutually destroy each other with the generation of energy. Of the degradation of matter to lower forms, we can have no doubt; of the building up we have no evidence on the earth, except in a very exceptional case to be mentioned again. But Millikan has interpreted the cosmic rays as the energy emission accompanying the building of atoms out in space, or as the newspapers have vividly put it, "the birth pains of matter."—S. C. Lind, Ph.D., *Dir. Sch. Chem. in Univ. Min. Techno-Log.*

ANCIENT ARCTIC CLIMATES

The old idea that Greenland and other arctic countries were once palm-filled tropical paradises is all a myth. These regions could not have been tropical, if for no other reason than that they have practically continuous night for several months each year. Even if it had stayed warm enough, the plants standing there in the dark would have starved for lack of sunlight.

This is one of the points raised in a discussion of ancient climates in the Arctic by Prof. Edward W. Berry of the Johns Hopkins University.

It has been found, upon examining all known kinds of fossil plants from the far North, that the great majority of them belong to temperate rather than tropical genera. In the more recent geological

periods they included such trees and shrubs as alder, sweet-gum, beech, oak, elm, maple, hickory, tulip-tree and sassafras, all of which are decidedly temperate-zone plants. Some more or less tropical trees have been found, such as fig and cinnamon; but cultivated figs generally ripen their fruits as far north as Baltimore, and that many of the trees that grow in tropic latitudes have their homes high up on the mountainsides, and are therefore really temperate-climate plants after all.

The plants of older periods, such as the coal age, have all disappeared from the earth, so that we cannot judge their habits and climatic requirements with anything like certainty. Such of their relatives as have survived, however, get along very well in temperate regions.

ASTRONOMICAL SPEED

See also Vol. II., pp. 144-149.

Apparently speeding away from the earth at the rate of 7,200 miles a second, a faint group of nebulae studied by Mt. Wilson Observatory astronomers sets a new astronomical record. Speaking before the Pacific Section of the American Association for the Advancement of Science, Dr. Edwin P. Hubble and Milton L. Humason told of their studies which make most previously measured astronomical speeds and distances fade into relative insignificance.

The nebulae studied form what is known as the Ursa Major cluster, and are in the bowl of the Great Dipper, near the star under the point where the handle joins the bowl. Though too far away to be studied in detail, each member of the cluster is undoubtedly a swarm of stars, like the milky way system.

The observatory's 100-inch telescope, largest in the world, was the instrument that revealed this high apparent speed. By making a time exposure of fifty hours, on nine separate nights, a photograph was obtained by Mr. Humason of the spectrum of the brightest nebula in the group. This proved to be similar to the spectrum of the sun. The dark lines crossing it, each indicating the presence of a certain element, were not in the position they would occupy if the light came from a terrestrial source. Instead they were displaced to the red end of the spectrum. Ordinarily such a shift is taken to indicate a motion of the light source away from the earth. Such a motion spreads the light waves out, making them longer, or redder. If the object is approaching, they are squeezed together and made shorter or more violet in color.

On such a basis, the shift observed was indicative of a speed of the nebula away from the earth of 11,500 kilometers per second. Previously he had discovered some other record high speeds, such as 7,000 kilometers for a group in the constellation of Coma Berenices, 5,100 for a group in Perseus, 3,400 for one in Pegasus and 900 for one in Virgo.

For some years Dr. Hubble has been studying these nebulae in various ways. In

1924 he announced his first results, which solved an astronomical problem of long standing by proving that these spiral nebulae are actual galaxies of stars, beyond our own system. Though this was done with a couple of the very closest of the nebulae, by methods which could not be applied to the fainter, smaller and more distant ones, he found that he could get a determination of their distance from a measurement of their size or brightness. The nebulae all seem to be of roughly the same size. The small clusters consist of small and faint nebulae, so apparently they appear small only because of their great distance. From comparisons of their size, he has determined the distance of those whose "speed" was measured.

Even before the study of the Ursa Major cluster was completed, a direct relationship was found between the apparent velocity and the distance; the farther away the faster the recession from the earth. Using this relationship, Dr. Hubble predicted that Mr. Humason would obtain an apparent speed for the group of about 12,000 kilometers per second, corresponding to its distance of 75 million light years. The most distant stars in our own system are of the order of a hundred thousand light years, a light year being equal to about six trillion miles. When the velocity of the Great Bear cluster came out at 11,500 kilometers, the prediction was abundantly justified. As the relationship holds very closely for all the cases which have been studied, it is believed that the method can now be reversed. By measuring the apparent velocity of a nebula, its distance can be determined.

Just what these high speeds mean is not certain. More probable is the hypothesis that something happens to the light waves as they travel through space, which spreads them out in just the same way as a motion of the source. The curvature of space, proposed by the Einstein theory, by which space itself is curved in higher dimensions, just as a ball is curved in three dimensions, has been given as one cause of such an effect.—*Science Service.*

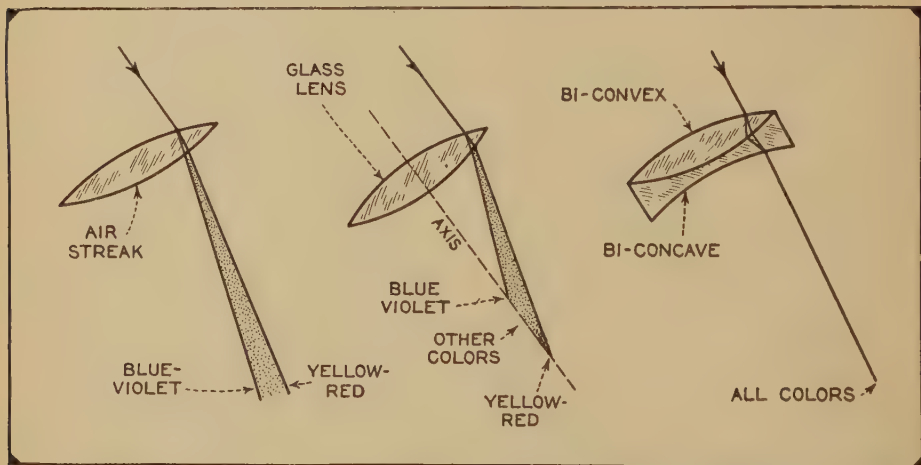
WHY STARS TWINKLE

Probably the first thing that many of us learned about the stars was that they twinkle, and the fact is obvious enough to deserve its place in the nursery classic. But does any grown-up, except perhaps an occasional minor poet, notice the phenomenon—and in particular what have the astronomers to say about it?

As a matter of fact the professional observer habitually scans the twinkling lights of heaven as he walks toward his

is technically called the “seeing”—that is, of the state of the air through which we must look. The late Professor Young, translating literally and with his characteristic jocular humor from some French book, used to repeat to his students, “The earth’s atmosphere is the astronomer’s black beast” and a *bete noire* it surely is.

Forget for a moment the clouds, fogs, smoke, and rain which so often blot out the heavens altogether and think of the



A streak of denser air high aloft (see left hand sketch, which is of course diagrammatic) affects the light rays arriving from space in the same way as a simple bi-convex, non-achromatic lens (middle sketch). In the case of the glass lens we can virtually balance out this “chromatic aberration” by adding a second lens (third sketch), but there is no convenient way of capping a dense air streak with a rarefied one, even from an airplane, and this is why the astronomer often must “go home to bed,” as Dr. Russell says in the text.

telescope and the more they twinkle the less is he pleased. Whenever the brightest stars, though low down in the sky, twinkle but lazily and those higher up shine steadily, he anticipates a good night’s work. But on our clear snappy winter nights, when the wind roars overhead and the brilliant stars are dancing and flickering, he hopes for little or nothing; and after one glance through his telescope he may even shut up shop and go home to bed.

For the twinkling of the stars is the best test that the unaided eye can make of what

limitations which even clear skies impose. Could we astronomers but live without breathing, and escape for our working time to an airless world, our lot as observers would be a happy one. With nothing above us to scatter the sunlight and veil the heavens with blue sky, we could see the stars as well by day as by night—and photograph them, too. The solar corona could be observed at any time merely by hiding the sun’s disk by a suitable screen placed in front of our telescope, instead of waiting years for a total eclipse. Best of all, our spectroscopes could get at the far

ultra-violet parts of the spectrum of the sun and stars, which is utterly and hopelessly cut off by the absorption of light of this sort in the upper atmosphere and which probably contains more things of astrophysical interest than all the parts that we actually can observe.

But let all this pass again and write it off as hopeless, even to dream of. Even so, the cloudless sky still is too often our worst enemy. The atmosphere is lamentably far from being optically satisfactory to look through. It refracts light, which would not be a serious matter if it were only homogeneous—but this it never is. The air is full of streaks and patches of different temperature and unequal densities, which are carried along by the wind and churned into a still more turbulent complexity wherever the wind is puffy or where winds blow in different directions at different levels. Large scale disturbances of this sort are often directly visible as dust whirls near the ground, or as the long parallel streaks of cloud in the "mackerel sky." They are all too familiar to the airman, too, as the "bumps" which make flying uncomfortable and occasionally even dangerous.

These larger irregularities are not always present, fortunately for the astronomer, but the smaller ones are always there and make trouble enough. Looking through them is, on a smaller scale, like looking up through running water or the rippled surface of a pool. Every streak of denser or thinner air, like the crest or trough of a ripple, acts as a lens would do to concentrate or spread out two originally parallel rays of a star's light. If only the starlight was strong enough, said Young many years ago, we should see on a white surface illuminated by it a moving pattern of lighter and darker patches resembling that formed on the sandy bottom of a pond when the sun shines on its rippled surface.

This prediction can be verified by anyone with keen eyesight who takes the trouble to find a dark room with a window free from all disturbance from artificial lights and let the light of Sirius come through the window (stopped down to a couple of feet square) and fall on a white sheet a dozen or more feet away. Until his eyes are fully adapted to the pitchy darkness, which will take 15 minutes or

more, he will see very little. But then he will find that the patch of starlight on the screen is distinctly visible, even for considerably fainter stars, while for Sirius it is bright enough to exhibit the shifting lights and darker patches which Young predicted. Now imagine an observer looking through a hole in this screen. As the brighter or fainter patches pass over it he will see the star increase or diminish in brightness. In other words it will *twinkle* and of course it will do so just the same if the screen is not there.

We see now, not only why the stars twinkle, but why their twinkling gives really valuable information to the astronomer regarding the state of the air—much better, indeed, than could be obtained by looking, even with the sharpest eyes, at a screen illuminated only by the feeble light of Sirius. It is clear, too, why stars high in the sky twinkle less than those lower down, for the rays of the first traverse a smaller thickness of air and so pick up less trouble.

Why bright stars seem to twinkle more than faint ones is not so obvious, the explanation being that rapid changes in the fainter object are less conspicuous to the eye than in the brighter one.

No explanation is needed why the stars twinkle more on a windy night than on a calm one. Indeed, when they twinkle violently on a night when there is a calm or a light breeze at the ground it is very probable that it is blowing half a gale higher up.

It is obvious, too, why terrestrial lights usually twinkle when seen at a distance of some miles, especially when seen through a wind or across ground from which heated air is rising, or from the deck of a moving steamer—as the writer has this moment seen the lights of a Greek seaport, twinkling furiously.

The planets do not twinkle, at least under any ordinary circumstances—which affords one of the simplest rough-and-ready tests by which the novice may distinguish them from the stars. The reason again is simple. The planets, unlike the stars, show disks of considerable angular diameter. The lines along which light enters our eye from different parts of the planet diverge when followed backward. The rays from opposite sides of Jupiter, for example, which enter the same eye

were more than a foot apart a mile farther back on their course. If we could isolate the light from any one small portion of the planet it doubtless would twinkle, but the different parts do not keep step in their twinkling and so the whole amount of light received by the eye does not change perceptibly. That this is the true explanation is shown by certain exceptions which prove the rule. Mercury, which shows a small disk, often twinkles, and so may the larger planets when seen near the horizon through turbulent air.

A star, when it twinkles, changes not merely its brightness but its color, especially if it is at a low altitude. How great these changes are is not generally realized because they usually happen too fast for the eye to follow. A simple device reveals them. Look at the star with an ordinary field glass and swing the glass rapidly with a sort of conical motion (a thing easier to do than to describe in a few words) so that the star appears to follow a rough circle within the field of view. If the motion is fast enough the luminous point will appear to be drawn out by the persistence of vision into a curving line of light. A star which is not twinkling gives a uniform line but one which is, shows a surprising variation both in the intensity and color of the light. On a night of bad seeing the luminous line is beaded with patches of brilliant color, almost like the flashes from a diamond. When the glass is held still the successive changes, which may follow one another 20 times a second or more, become partially though not wholly fused into the familiar flickering image.

This remarkable and beautiful phenomenon was first explained by the Belgian, Montigny, more than 70 years ago, but it still is not as widely understood as it ought to be, and the writer owes the account which follows to the excellent Italian treatise of Professor Armelline of the University of Rome.

Owing to the refraction of light in the atmosphere the rays of starlight which traverse it are not quite straight, but are curved slightly downward as they go deeper. Blue and violet light are refracted more than red and yellow, so that the corresponding rays are more curved. If, then, we have a streak of air high up which, for example, acts as a convex lens, the red and blue rays, though both concentrated

into bright patches of starlight on the earth's surface, will pursue paths of slightly different curvature and will not reach the earth in the same spot. If, then, we could see the patterns cast on the surface by the red and blue light separately, we would find them very similar in design but shifted laterally with respect to one another.

For a star in the zenith, indeed, the rays would come down straight and there would be no shift, but in all the cases the red and blue patterns would be out of register by an amount increasing as the star's altitude diminished; and also of course the higher in the air were the regions which produced the pattern. The actual light pattern would be very complex, composed of patterns of all colors, some more out of register than others. But it is evident that, from point to point in it, any given color might happen to be intensified, and any other (not too nearly like the first) might be weakened. The resulting pattern would therefore be irregularly and sometimes strongly colored and as it drifted past an observer's eye the star would appear to change in color as well as in brightness. There can be no doubt that this is the true explanation. It is confirmed by the fact that conspicuous changes of color appear only in stars at a low altitude, for which the curvature of the rays is greatest.

When viewed with a telescope, especially a large one, the appearance of a twinkling star differs greatly from that which it presents to the eye. The changes in brightness and color are far less conspicuous, but the star images at times of modest disturbance appear to shift and dance irregularly about. When the seeing is really bad the image is distorted and refuses to come to any sharp focus, but is continually "boiling" and shifting; and sometimes it "explodes" into a diffused mass of considerable size.

All these effects again are readily intelligible. The rays which strike different parts of the objective of the telescope and are brought by it to one focus have traversed different paths within the atmosphere, so that some of them may be weakened at any given moment and others strengthened. The changes in brightness of the integrated image are therefore pretty well ironed out, and the same is true of the color.

On the other hand the small lateral deflections of the direction of the ray as a whole, which are usually quite imperceptible through the unaided eye, become visible and often conspicuous when magnified. When the disturbance pattern in the air is on a large scale all the rays which enter the objective of the telescope may be deviated in the same general direction, and as this changes from moment to moment the image dances. When the pattern is small the rays entering different parts of the objective are deviated in different ways and the image refuses to come to any good focus but boils, and in particularly bad moments it explodes. This sort of trouble evidently should be most frequent with large telescopes, and so it actually is found to be.

Atmospheric disturbances of all these kinds are among the worst defects that can afflict an observing station. It is no won-

der then that when a great observatory is being planned careful tests of seeing are made at many proposed sights and often enough to get a good average representative of conditions the year around. For work of this importance a telescope of several inches aperture in the hands of an experienced observer is necessary. But in the preliminary reconnaissance which selects the places for further testing the simple observation with the naked eye of the twinkling of the stars should suffice to exclude many hopeless situations and pick those which are more promising.

So the modern astronomer who sees the little stars twinkling—and the brighter ones still more—moves on, fearing that, should he set up his telescope in so ill-favored a spot, he might find it useless for the greater part of the time, and be left “wondering” what the stars “are,” rather than finding out.—*Henry Norris Russell, Ph.D.*

CHESS

The word chess is derived from the Persian shah, king; checkmate or shahmat means “king confounded or overcome.” The origin of the game of chess is undoubtedly Oriental, but its date is lost in antiquity. Terms connected with it are found in the Sanscrit, as well as other Asiatic languages. Some authorities give the credit of inventing the game to Palamedes, a Grecian hero of the Trojan war, about 1080 B. C. A game essentially the same as modern chess was played in Hindustan nearly 5000 years ago. The original Hindu game was played as now, on a board of sixty-four squares, but by four persons, two being allied against two, as in whist. From Hindustan, chess spread into Persia and thence into Arabia; the Arabs, it would seem, introduced the game into Spain in the eighth century, and thence it spread through Western Europe. In England the game seems to have been known prior to the Norman Conquest. It is the most intellectual of all games of skill, involving the faculties of both

memory and foresight to a large degree. Dr. Benjamin Franklin admired the game greatly, and wrote upon the advantages gained by it in the cultivation of the mind and character, particularly in the promotion of the habit of circumspection. With Napoleon I it was a favorite recreation, and many men of superior intelligence have enjoyed it. The great American chess player, Paul Morphy, visited Europe in 1858 and conquered in turn all the most distinguished living players of his day. His most interesting feat was playing, blindfold, six games at once, with as many different players, and winning them all. The names of what we call “Chess-men” are: King, Queen, Bishop, Knight, Rook (or Castle) and Pawn. The term rook is from the Sanscrit roka, Persian rukh, meaning a ship or chariot; pawn is said to be from peon, an attendant or foot soldier (Latin pes). The books written upon the subject of chess alone would form a library of considerable size.

VOLCANOLOGY

It may seem strange to many people to learn that the recent campaign suggested by the *Scientific American* for interesting amateurs in seismology promises to be of great assistance to volcanology. What is volcanology? A tourist, who recently visited Kilauea Volcano in Hawaii while it was sleeping, expressed the popular viewpoint. He saw the observatory and learned of the existence of a volcanologist. "What a cinch," he remarked, "nothing to do but wait for an eruption!"

It had never occurred to him that some of the fundamental processes of volcanology are happening under Iowa at his home town. It had never occurred to him that possibly the recent Mississippi flood with its losses of three hundred millions of dollars is not unrelated to the forces that made the New Madrid earthquake in 1812. The science of the earth is all one thing whereby the continents rise, erosion carves out the valleys, sedimentation fills the mediterranean seas (of which the Gulf of Mexico is one), and the sea bottoms lower. There is a shift of matter under or within the crust of the earth from the heavier regions to the lighter. There is every reason to suppose that this matter is magma, which makes the intrusive rocks at the core of our mountain ranges, or the lavas which pour out at volcanoes.

Volcanology is concerned with the movement of magma. This movement is going on all the time somewhere, rapidly in some places, slowly in other places. It is probably much more important to mankind in its buried movements underground than in its visible movements at volcanoes. These buried movements and shifts of magma lift the mountain ranges at the sources of the Mississippi, lift shore lines in California and Japan, are somehow concerned with the scorching heat under the steam power plant at Geyserville north of San Francisco, and the high temperatures of our deep oil wells, and play their part in the stresses that make big earthquakes.

Science is gradually learning that what is happening under your home town in Montana or Pennsylvania or Louisiana, at a depth of about 35 miles, is equally important with what is happening in the air

30 miles above you. The aviators and the radio people need all possible knowledge of the air. The geologists need all possible knowledge of the earth and the relations of its gases, pastes, and solids. We explore the air with balloons and radiation. The oil people are beginning to explore the earth with echoes, conductivities, magnetic needles, and torsion balances. Volcanology needs the assistance of amateurs to microscope the tiltings and tremblings of vast continents, because without them the job appears to be too big, even for the government.

This makes volcanology something very different from what you thought. Nevertheless, the study of volcanoes and volcanic eruptions is a part of the game. For volcanoes have the advantage that they lie over places where the earth crust is thin, where the ground is hot close to the surface, and where the lava may sometimes actually be seen emerging. In a general way all the active volcanoes of the present day lie at places where there was much greater volcanic activity in Tertiary time. That is, there are more extinct volcanoes at the volcanic districts of the world than there are live ones. Volcanism today is decadent. In the economy of the earth there have been geologic ages representing big cycles when the crust heated up and cracked, and volcanic magma poured out. The Miocene Tertiary was the last of these.

Decadent volcanism, however, in a volcano belt does not necessarily imply decadent magma underground. The magma underneath a chain of volcanoes may be engaged in processes of intrusion at the present age in a fashion much more lively than that which underlies Iowa and Pennsylvania. If we can make our instruments sensitive enough to show the same kind of motion under both Hawaii and Pennsylvania, but quantitatively greater in Hawaii, we are creating a science of volcanology wherein nobody has to wait for "eruptions." The popular conception of an eruption as something violent, steamy, and explosive is based on a very occasional happening at volcanoes, not at all characteristic of that flow of magma which has

done most of the building of the great volcanic lands of the world. Volcanoes show us magma flowing out as lava, and a sensitive pendulum set up on a volcano shows us the ground tilting and trembling as a result of the magma spreading underground as an intrusive, or escaping elsewhere as an outflow. This is what makes a volcano so valuable as a natural laboratory. If we may correlate the physics of the ground with visible flow of magma, we may then go elsewhere and interpret underground flow of magma from measurements of the physics of the ground.

The original study of volcanoes began with human necessities. Bad eruptions happened at Vesuvius, and the meteorological observatory there turned its scientific work in the direction of keeping a journal of what the volcano was doing. A bad earthquake happened at Naples, and Mallet made some interesting studies of how the buildings were thrown down in relation to a supposed center of bumping underground. The buildings were cracked at right angles to lines extended-out in all directions from the center of the shock. If this theory worked, then a building right over the earthquake center, or at the epicenter, ought to be jolted straight up and down, and cracked horizontally. A building far away to the east of a shallow center should be broken vertically along north and south cracks.

If earth movements were as simple as this, the study of earthquake sources would soon become an open book. It was originally thought that steam explosions and collapses underground accounted for earthquakes near volcanoes. Then it was argued that these things are very small, and that volcanic earthquakes are very small. When a very big earthquake happened, like that at Messina, near Mount Etna, it was argued that this could have nothing to do with the volcano, because the volcano did not erupt at the same time. Geological text books have rung the changes on this argument, distinguishing between tectonic and volcanic earthquakes. Tectonic earthquakes are supposed to be crustal movements that have nothing to do with magma, but are occasioned by expansion or contraction or pressure such as are involved in the world forces which build mountain folds and faults in strata. The modern volcanologic viewpoint is that

earthquakes occurring at an active volcano may be large or small, shallow or deep, usually occur at faults and not at craters, and represent forces which may be either tectonic or magmatic, according to the way in which those terms are defined. As we have magmatic movements of intrusion and continental balance under the mountains, and as we have crustal movements of pressure, expansion, and contraction under the volcanoes, and as nobody knows what makes an earthquake anyway, the guess of every amateur seismologist is just as good as the next man's.

Between 1891 and 1923 there grew up in Japan a science of field seismology led by Dr. F. Omori. Japan is a land of earthquakes and volcanoes mixed together. Dr. Omori devoted himself at first to devising seismographs and spreading them among the meteorological stations of Japan. He measured thousands of earthquakes. Very exceptional earthquakes were accompanied by big fault cracks, the sides of which moved up or down or sideways. Geologists have the habit of pouncing joyfully on these exceptional ones and concluding that the accumulated stress in the rock at the side of the fault crack was released when the fault gave way and that this yielding to accumulated stress is the usual cause of great earthquakes. Oldham, a distinguished geologist of India, has combated this notion with the argument that the stress is developed very suddenly in the deep region. Omori found out that earthquakes are far from simple, that big ones may occur in the midst of a big volcanic eruption, or near a big volcano not in eruption, or in a district not recently volcanic at all, and that some of these earthquakes have obvious fault movements and that some show no obvious faults at all.

This last fact had been observed by Oldham in India, by the Americans at the New Madrid earthquake of 1812, and by Major Dutton at the Charleston earthquake of 1886. Omori came more and more during the last fifteen years of his life to devote himself to the study of volcanoes, for he saw that there is an infinite series of earthquakes, small to great, somehow related to magma. He and his successors have learned in Japan that both volcanic eruptions and strong earthquakes are accompanied by topographic changes of ele-

vation of the land. In using the expression "volcanic eruption," in this sense, the reader should remember that flow of magma is meant. A big gush of explosion with ash and steam is not essential to a volcanic eruption, and a retirement of lava straight downward under a volcano crater might be accompanied by a very important "eruption" or flow of magma. In this case the eruption would be a flow of lava from a rift under the sea which nobody would notice, unless the volcanologists were using their wits. And seven tenths of the geology of the earth is under the sea.

In 1911 an observatory was started at Kilauea Volcano in Hawaii, which the writer has had the honor to operate. This also was influenced by the humane viewpoint, for the terrible disasters at St. Pierre, Vesuvius, Jamaica, Messina, Etna, and Costa Rica had induced donors to create an endowment in the Massachusetts Institute of Technology for geophysical study that might lead to amelioration of conditions in earthquake lands. The observatory was started by the Massachusetts Institute and carried on thereafter by the Hawaiian Volcano Research Association assisted by the government. The Hawaiian Volcano Observatory kept a diary of everything that happened at the Hawaiian volcanoes and measured everything that was measurable within the limit of funds at its command. The volcanoes were mapped, the Kilauea lava pit was mapped again and again as its lava topography changed, leveling circuits were occupied repeatedly, a seismograph station was set up at the crater and afterwards supplemented with other stations about the island, and experiments were inaugurated.

The experiments proved, by the use of different kinds of thermometers and pyrometers, that the liquid lava grows hotter from below upward, just as it grows more foamy from below upward, as the bubbling gases are released from solution in the melt beneath. This melt is very dense under pressure down deep, and as the gases escape to the bubble form under release of pressure, they react with each other and with air to produce combustion of hydrogen, carbon monoxide, and sulfur gases along with rise of temperature. A lava eruption is thus a heating expansion of slag foam. This was a new idea. When this basaltic foam spreads out in the crater

or beyond, in contact with atmospheric temperatures, it freezes, and in the crater pits it is engaged in an incessant struggle with congealing cold.

The topography of the top of the live lava column in Kilauea Crater becomes diversified into crags, floors, and lakes of lava. A series of experiments with steel pipes was initiated whereby it appeared that the liquid lakes are only 40 or 50 feet deep, with wells and tunnels feeding them. These wells and tunnels are not in the solid rock of the mountain, but form a honeycomb in the partially hardened lava that underlies the crags and floors. This hardened lava column is red hot and pasty, with tubes leading up through it to the shallow saucers of foamy lava on its top, while somewhere down deep both the pasty lava and the liquid merge into the very stiff primitive rising lava, under great pressure, and with the gases in complete solution.

This primitive stuff nobody has ever seen. When it is released from pressure to froth into the region of man's ken, it changes, heats, gassifies, and oxidizes to a glassy foam mixed with burning gas which may be very unlike the mother magma. The partially congealed refuse of this makes the lake bottoms, crags, and floors, and this paste rises and falls majestically as the main lava column in the pit, with the liquid lakes rising and falling at about the same rate on top of it, but with small differences between the two from day to day. The discovery of the difference between bench lava and liquid lava was another new idea.

With all this rising and falling, measurable with reference to the bench marks on the edge of the crater, it became of interest after 15 years of work to see how the curve of up and down compares with past curves. It was well known from the work of the devoted missionary Coan in the middle of the 19th Century, that Mauna Loa had more than a dozen outpourings of lava in great streams sometimes 60 miles long, and that Kilauea had lava in its pit most of the time. There had been some hint of a cycle about nine years long. The Hawaiian Volcano Observatory uncovered a cycle between 1913 and 1924, eleven years long, with the pit very deep and inactive at both ends of this time. Moreover, the lava rose from 1913 to

1919, sank from 1919 to 1924, and crashed down with a great engulfment of the walls of the pit in the last named year. Along with this culmination of 1919, Mauna Loa showed increasing eruptions in sympathy with the Kilauea cycle. The 11-year period was compared with what is known of the 19th Century, and it was discovered that the high levels agree very well with years of maximum sunspots, and that 12 cycles of 11.1 years each from 1790 to 1924 agree better with the facts than the older conception of a nine-year cycle. It happens, too, that this is just the sunspot average.

The facts indicate that Mauna Loa and Kilauea alternate somewhat, and that there is a greater cycle 134 years long during which the lava of the entire Hawaiian system rose to a culmination of outpouring about 1855, declining thereafter until 1924, when there was an explosive eruption at Kilauea, and very probably a submarine lava flow under the deep sea off to the east. The supercycle had followed an explosive eruption at Kilauea in 1790, and this larger interval of something like 130 years corresponds to similar periods in Japan and Italy elapsing between great earthquakes or great volcanic eruptions at the same place. It is reasonable that magma should move in waves of accumulated gas pressure and release, and also there may be astronomical controls in these cycles.

The volcano seismographs at Kilauea have indicated thousands of earthquakes, and by comparing the records with those of the secondary stations and with the reports of felt earthquakes at habitations, it has been possible to locate groups of earthquake centers. These have often corresponded fairly well with known volcanic fissures or faults, sometimes when the fissures in question broke into eruption and gave vent to lava flows. The earthquake centers rarely correspond with summit craters. Often the earthquakes, registered by a pendulum and a pen writing on smoked paper, are accompanied by a swinging off of the pendulum to a new position after the earthquake. This means that the ground has tilted during the earthquake. These tilting movements have been compared with changes of level of the country as proved by geodetic levelings. It has been discovered that Kilauea Mountain rose more than two feet while the

lava was rising in the seven years following 1913, and sank by a similar amount during the explosive engulfment of 1924. And the pendulums indicated the actual months of maximum tilting, as corresponding with times of maximum lava pressure and lava withdrawal.

All of this means that land underlaid by magma is subject to swelling and shrinking forces, and it will prove increasingly fascinating to harness these forces with simple instruments and volunteer observers until the centers of motion, and the relative motions of different places, have been discovered. To anyone who has worked where these motions are rapid and strong, as on Hawaii, it appears that the geographical facts of distribution of motion, in relation to volcanic centers, are much more needed than precision work at one place. That is where the amateur and volunteer will come in, and consequently the simplification of instruments appears to the writer to be the most important need of seismology.

What is the use of volcanology? On the answer to this depends in part how we ought to attack the science. If we are interested in theories of the earth's internal elasticity, of its heat, of its gases and radioactivity, and care nothing for the effects of volcanic eruptions and earthquakes on mankind and his cities, we should devote ourselves wholly to precision laboratories with only minor attention to geography. But there comes into the argument the Mississippi flood, the devastating tidal waves, the failure of gigantic engineering works at times of great earthquakes, and destruction of cities such as St. Pierre. If a great insurance company were to create a research laboratory of volcanology to solve company problems, what would they demand? They would certainly demand, first, attention to engineering and to geography. In other words, the human need for a science of eruption, of deformation, of sedimentation, and of erosion calls for field laboratories eternally measuring the observatory methods the quantitative aspects of those processes. All the processes are tied together as affecting the pipe lines, dams, railways, farms, cities, roads, bridges, wharves, levees, aqueducts, wires, harbors, and fills on which human beings have spent billions of dollars.

As it is, the science of volcanology quite apart from volcanoes, is the forerunner of a new science of the earth, which at this moment in America is being greatly assisted by the new flood-relief measures carried out by the government on a gigantic scale on all the rivers of the United States. Probably few people realize that this study of earth process is the pioneer of a science of geonomy, the workers of which will be geomomers living at observatories and actuated by the same spirit as astronomers. Erosion science has hardly been touched, yet mountain canyons are falling down all the time and their wreckage is being swept to the ocean. It is a

marvelous opportunity for new measurements and new instruments. Mountains are heaving up, continents are tilting, flood plains are shifting, waters are muddying and clearing, bays and lakes are filling, the bedrock is shaking and, under all, the magma is welling under the crust of the earth, warming the hot springs, heaving the hills, and accounting for a hundred unmeasured phenomena up and down the Pacific Coast and Alaska, as well as in Arkansas, Virginia, and the Adirondacks. With simplified instruments and hundreds of amateurs, we may expect the natural history of the earth to take a new lease on life.—*T: A. Jaggar, U. S. Geological Survey.*

“PTOLEMY'S MIRROR” AND THE PHAROS

We read in several ancient authors, that Ptolemy Euergetes caused to be placed in the tower of the Pharos (the lighthouse built by his father), at Alexandria, a mirror which reflected all of lower Egypt and the sea to a distance of 100 leagues, so that when seated in the tower, he could note the advance of an enemy's fleet by sea, or any disturbance in his kingdom on land. Abulfeda, in his description of Egypt, says that the mirror was of Chinese iron, and, that soon after the Mohammedan conquest, the Christians destroyed it by stratagem. Buffon thinks that by Chinese iron Abulfeda means polished steel. The story of this wonderful mirror has been very generally treated as a fable; but some celebrated opticians have been so staggered by the positive terms in which the facts stand recorded, that they hesitate discrediting it altogether. One says, “After perusing Father Abbot's proofs and illustrations, no one need blush for his philosophy in a belief in the actual existence of the long-reputed fable of Ptolemy's mirror.” The Pharos of Alexandria, accounted one of the Seven Wonders of the Ancient World, was the first light-bearing tower of which we have record. It was built of white marble, several stories high, each story

diminishing in size toward the top; the top story had a gallery running round it, supported on the outer circle of the story beneath. The ascent inside was such a gentle incline that horses and chariots could easily accomplish it. The cost of the Pharos is said to have been 155,000 pounds sterling; it was built by order of Ptolemy Philadelphus (309-247); the inscription read, “King Ptolemy to the Savior Gods, for the use of those who travel by sea.” According to the Arab historian Abdel-Atif, this wonderful structure was still existing in the thirteenth century, but no remains of it are now to be seen. The Pharos stood on a rock detached from the extremity of the island of Pharos in the bay of Alexandria, from which it takes its name; thus originated the generic name Pharos in the classical languages for “light-house.” The lighthouse was connected with the island by a wall, and with the mainland by the Heptastadium. The name of this causeway, which served as an aqueduct as well as a road, was derived from its length of seven stadia, about three-quarters of a mile. The old lighthouse of Alexandria now occupies the site of the ancient Pharos. Modern Alexandria is largely built upon the Heptastadium.

AMATEUR SEISMOLOGY

In a recent number of the *Scientific American*, readers who were interested in seismology were asked to write to the editor. This "feeler" brought a fair volume of response, and we now give in the following pages a description of a small home made seismograph known as the "Jagggar shock recorder." This is for recording local disturbances, not only earthquakes but also those due to truck traffic, blasting, railroads, and so on. The average amateur should be able to construct the apparatus described at a cost of about 25 dollars.

At the present time there is a lack of literature on seismology, a situation which is likely soon to be remedied. Much the same situation existed four years ago when a start was made to popularize amateur telescope making. Starting with what literature was then available the amateurs went ahead and constructed telescopes, and the demand for literature thus created was soon answered by a supply.

There are no practical instruction books for making seismographs; also there are few books on seismology itself, none of which are up to date, although a noted authority is known to be preparing one at present. Professor W. H. Hobbs' "Earthquakes" is out of print; Davison's "Manual of Seismology" is not very suitable for the beginner. The *Bulletin of the Seismological Society of America*, published quarterly, contains much earthquake information, some of which is not abstruse and recondite.

Thus, without practical instruction books and with scant literature on earthquake science the amateur will be called upon for a time to make use of his "wits." Our past experience with amateur telescope work indicates, however, that this is just what the average intelligent amateur worker likes best to do. If a thing is too easy it is not much fun.

The following matter will open the SCIENTIFIC AMERICAN amateur seismograph making campaign. It consists of parts of two letters, a short article from a scientific journal, and a paper describing the shock recorder, each written by Dr. T. A. Jagggar, Director of the

Hawaiian Volcano Research Association, Section of Volcanology, United States Geological Survey, Volcanologist in Charge of the Hawaiian Volcano Observatory.

Dr. Jagggar writes: "Your letter interests me greatly, because I believe wonderful work to improve seismology could be done by amateurs. The case is like astronomy, photography, and radio, in that respect.

"There are five principal kinds of movement of the ground:

(1) Local earthquakes, which range from tiny tremors to felt shocks; the Carnegie Institution registers 200 to 300 little ones a year at any one station in southern California; about 900 at four stations roughly 100 miles apart.

(2) Distant earthquakes, of which there average 20 world shakers, and 57 that register half way around the world every year. This gives the distant earthquake specialist a chance of averaging one a week, with long spells, however, of not any, and short spells of several that come together.

(3) Microseismic movement, a slow-period wave movement of the ground (about five seconds), not understood, and very variable, thought in some cases to be due to ocean waves on cliffs far away.

(4) Quick period tremor long continued; observed at Tokyo, at volcanoes, and probably at other places. Little studied except at Kilauea.

(5) Tilting movements of the ground. These movements should have special instruments. They are being studied in some laboratories. They are very interesting adjacent to river floods, big tides, landslides, volcanoes, and earthquake faults.

"There is a splendid book in German, 'Erdbeckenkunde,' by A. Sieberg, published in Jena, by Gustav Fischer (1923). There is nothing in English that is up-to-date.

"With reference to popularizing seismology, there are all the different kinds of natural and artificial motions, such as waterfall jarring, wave action on shorelines, factory tremor, city tremor, river flood effects, continuous landslip in moun-

tains, traffic jarring, blasting, railroads, and other things now unsuspected, in which amateurs might get interested in unique places. If the amateurs were physicists, they would do as much for seismology as they have done for astronomy and photography. But they must interest themselves in all kinds of tremors. If they go in merely for earthquakes, many of them in certain localities will have long waits.

"Big gun concussions could be recorded as 'airquakes' distinct in time of arrival from 'earthquakes.' The elasticity of different regions is very different. Machines every third floor of a skyscraper would get a series of elevator machinery effects, wind effects, or traffic effects. This bears on architecture and strength of construction. Anyone living near a volcano, a geyser or a mine, would get many interesting records. People in limestone districts would get earthquakes from cavern breakdowns.

"You will see that all of this would lead to correspondence between amateurs working on different tremor problems, and the invention of all sorts of electrical registrations, some of which would improve the art."

In another communication, with regard to a shock recorder which the amateur may construct (see illustrations), Dr. Jaggar comments as follows:

"Please make it clear that this notice is preliminary. Our first model is recording shocks here beautifully and is keeping time. It stays on the job for big and little, felt and unfelt, local shocks, when the strongly felt ones dismantle our high-magnification instruments.

"The amateur's demand in feebly seismic districts is better suited to our larger machine of which I sent you the earlier blueprints. That is a machine for distant earthquakes. [Dr. Jaggar states that this machine could be built for 50 dollars.]

"The shock recorder applies to eastern Canada, the New Madrid district of Tennessee-Missouri, South Carolina, Montana, New Mexico-Arizona, Nevada, California, Hawaii, Mexico, and most of Alaska. In many places the earthquakes will not be exciting at all. In New England or Illinois the pendulum ought to be connected with a 400-day clock and run electrically, the earthquakes are so few.

"By changing the pendulum in the

shock-recorder to a slow period it could be made a teleseism-recorder: the stylus tip should be made very light. It would still record local shocks. This particular work would require some knowledge of physics on the part of the operator but the simple shock-recorder without the described change is comparatively easy to use."

The following is quoted from No. 226 of the *Volcano Letter*, a small, interesting weekly periodical published at the address stated above, and was written by Dr. Jaggar, who is its editor:

The effort to record time, duration, and size of an earthquake has heretofore appeared to require a masonry cellar at constant temperature, time-keeping like that of an astronomer, clockwork of the finest, observers directed by physicists, and five or six seismographs of different sensitiveness to be ready for big earthquakes, medium earthquakes, and little earthquakes. The Tokyo laboratory has 15 or 20 working instruments.

The present object is to secure cheapness and attractiveness, in order to get records of local motion from many places and to interest many people. This is what, for meteorology, makes the thermometer and the rain gage so useful.

There is an enormous moral and ethical inertia, and even resistance, to be overcome, in order to make the discovery of the distribution of small local earth motions interesting to the man on the street. Recently the presidential addresses of the Seismological Society of America, the work of several associates of the Hawaiian Volcano Observatory, an appeal from the president of a leading insurance company, and a letter from the *SCIENTIFIC AMERICAN*, have set the writer to experimenting, and the Jaggar shock recorder is the result.

The instrument that I have been using in the Kilauea station is made of a lead cylinder, hinged with two hack-saw blades, and writing on the face of an alarm clock. It produces an eight-inch paper disk with a line written around it like a gramophone record.

The operation is no trouble at all. The paper is smoked, runs a week, and is then dipped in dilute shellac. Any quiet corner away from machinery receives the box, about three feet long, which is screwed

down. It is sensitive so as to show our feeblest instrumental Kilauea earthquakes. The time is recorded by a dial printed on the paper. The cost is about 25 dollars.

The following paper, describing the shock recorder in detail, was written by Dr. Jaggar, for presentation before the Seismological Society of America:

The shock recorder is designed for the following purposes:

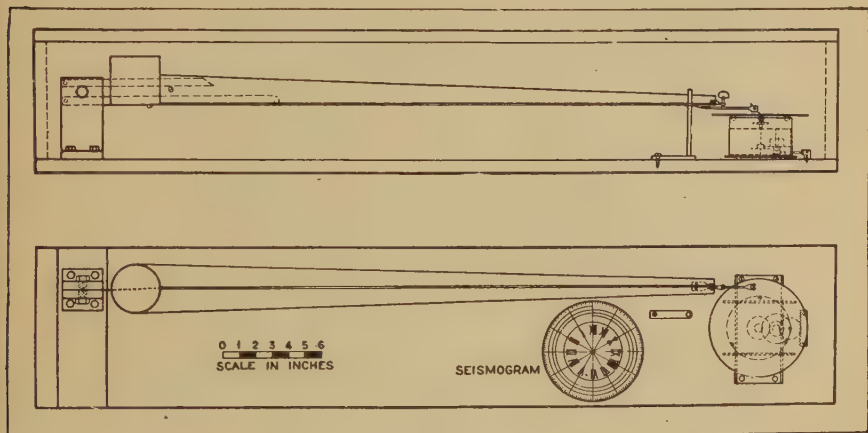
(1) To record local earthquakes in any house where reasonable rigidity and quiet can be found.

(2) To interest the general public in a cheap seismograph.

strument, its placing, or its management.

(7) To register earthquakes as small as R. F. 2 and as large as R. F. 9. [R. F. refers to the Rossi-Forel scale of intensity.]

There are many occasions when negative information is valuable in seismology. That a well known earthquake was *not* recorded at such and such a place is useful knowledge. That it was not felt, or that everyone slept through it, furnishes no positive information. That an instrument of R. F. 2 grade showed not a trace at the definite hour specified is a scientific measurement. Fifty such instruments giving records and non-records across 500 miles will pretty well delimit the shock.



1929 MODEL SHOCK RECORDER

(3) To furnish data of approximate time, duration, intensity, and location, without any technical skill being required, and with very little trouble in operation.

(4) To lead to the creation of enough of these instruments to furnish co-ordinate data, more or less reliable, geographically widespread, and related to a quantitative intensity scale.

(5) To produce an instrument made of common materials, that anyone may copy, and of standard dimensions and weight.

(6) To embody instrumental constants that are simple and relatively unchangeable, so that the records will vary with the phenomena recorded, and not with the in-

The shock-recorder is a single horizontal pendulum made of a post of angle irons, two hacksaw blades for hinge, a cylinder of lead weighing nine pounds, a long stiff light arm of thin aluminum carrying a very small free stylus, an ordinary eight-day clock which serves for both timepiece and drive, a rotating horizontal disk on the hour-hand spindle, a smoked registration card which is printed in the center as a reversed clock dial, a box, and a few bolts and screws.

The movement both drives the mechanism and keeps time for a week. The whole clock, with smoked disk facing upward, moves laterally two millimeters [a millimeter, mm., is about $\frac{1}{25}$ of an inch.]

on a straight track every 12 hours automatically. This has the effect of making the pen scribe a new circle offset two millimeters from the last one every half day. The card is changed and varnished at the end of a week.

The smoking is done with tongs having metal disk jaws just the size of the dial. The dial card is thus grasped by the tongs with the dial untouched by the smoking. The outer smoked band is 40 mm. wide.

The accompanying drawing shows the rugged pendulum, which weighs four kilograms, (8.8 pounds) and is adjusted to a one-half-second period. It is undamped and designed to synchronize with ordinary

support. This tends to instability, a desirable feature.

The boom is made of thin aluminum bent in the form of a paper arrow, 980 mm. long to the stylus tip from the center of mass. The boom encloses the outer ends of the hacksaw blades. The pendulum and clock are contained in a rectangular box 126 by 26 by 28 centimeters in length, width, and height, with a glass window at the right over the dial. The baseboard is screwed down in a closet, cellar, or other quiet place.

The operator sets up the instrument with the heavy mass preferably toward the north. The clock is lifted from its



STYLUS AND RECORDING APPARATUS

local earthquakes. It is not troubled by teleseisms or microseisms. The static magnification is 19.

The two horizontal hacksaw blades stand one above the other in the same vertical plane, and are pinched between angle irons bolted to the baseboard. They are 16 mm. apart, and the lead cylinder is cast about them, its longer axis upright, its bottom flush with the lower edge of the lower blade. The cylinder, 78 by 76 mm., hangs with its center 50 mm. from the upright line of support.

The lead weight is supported on the upper blade five mm. above its center of mass, and the suspension is largely in compression, with only the upper part of the upper blade in tension, at the line of

ring support, turned over, and wound. It has a common nickeled case, with the rotary disk of aluminum replacing the usual dial, and actually taking the place of the usual hour hand, with one revolution in 12 hours. The clock ring is on tracks fore and aft, and the replaced clock is slid forward until a protruding pinion engages a rack on the baseboard at the right. This is what moves the registration disk to write spiral records. The card dial is now smoked and laid on the disk over the clock. Meanwhile the pendulum boom has been locked by a wooden button away from the clock. This bolt is released and the stylus comes over the smoked card-board. Before the stylus is dropped on the smoke surface, the card dial is rotated un-

til the actual time corresponds to that part of the dial opposite the stylus position. Then the stylus tip is overturned on to the smoke. The machine is now a time-piece and a shock-recorder for a week.

It may be examined every day through its window. At the end of the week the card is removed and shellacked. Every successive revolution corresponds to the 12 hour period indicated by the dial. All are on a disk or glossy cardboard six

inches in diameter. Earthquakes from grades 1 to 9 Rossi-Forel will appear as white cross lines, in length from a fraction of a millimeter upward. The time line is about 35 mm. to the hour, permitting some evaluation of earthquake duration with a magnifier.

This machine in the hands of insurance companies, school teachers, and interested amateurs should be a beginning of quantitative data from popular observation.

"O. K."

In colonial days the best tobacco and rum came from Aux Cayes. Thus anything considered all right was designated as Aux Cayes, pronounced O. K. In Jack-

son's Presidential campaign his opponent attributed the use of O. K. to his alleged inability to spell "All Correct" (Oll Ker-rect).—*N. Y. World*.

DRESSING FOR DINNER

Dressing for dinner as we observe it today is a punctilious ancient custom handed down from the Romans who put

on a loose robe of light texture before sitting down to the most important meal of the day.—*N. Y. World*.

"SUB ROSA"

Sub Rosa means, literally, "under the rose." The phrase dates from 477 B. C., when Pausanias, the commander of the confederate fleet of the Spartans and Athenians, was engaged in an intrigue with Xerxes to betray Greece to the Persian rule, and to obtain the hand of the monarch's daughter in marriage. Their negotiations were carried on in a building attached to the temple of Minerva, called the Brazen House, the roof of which was covered with roses. The schemes (planned with the utmost secrecy) were matured literally "under the rose." Pausanias, however, was betrayed by one of his emissaries, who by a preconcerted plan, enabled the ephors (the five overseers and counsellors of state) to hear Pausanias criminate himself. To escape arrest, Pausanias then fled to the temple of Minerva, and the sanctity of the place forbidding intrusion for violence of any kind, the people walled up the edifice with stones and left the fugitive to die of starvation; his own mother laid the first stone. It after-

wards became a custom among the Athenians to wear a rose when they had a confidential communication to make, the flower implying strict confidence. There is also a mythological significance to "sub rosa." Cupid gave Harpocrates (the god of silence) a rose to bribe him not to betray the amours of Venus. Hence, that flower became the emblem of silence. It was for this reason sculptured on the ceilings of banquet halls, to remind the guests that what was spoken sub vino was not to be uttered sub divo. These phrases have been translated: "What we say when drinking high, utter not beneath the sky." It was customary among the ancient Germans, on occasions of festivity, to suspend a rose from the ceiling, above the table, as a token that whatever was said during the feast by those present should afterwards be forgotten, or at least kept secret among themselves. In 1526 a rose was placed over confessionals in Roman Catholic churches.

CHEMISTRY IN 1929

Chemistry made spectacular advances during the year, according to "Industrial and Engineering Chemistry."

If 1929 is reviewed seriously with the idea of attempting to point out its achievements of a chemical nature, a most bewildering state of mental equilibrium results, declares the journal in reaching a balance among what it calls the clamoring items of a most kinetic world.

In prolonging human life, in aiding aviation, in revising old concepts, in building up industry at home and abroad, in developing for American men of science a worldwide system of abstracting chemical literature, in effecting industrial co-operation, and in the advancement of industrial chemistry and chemical engineering, The Chemical Kaleidoscope for 1929 mirrors a long list of conquests.

It was the year of the Graf Zeppelin's flight around the world, of Light's Golden Jubilee in honor of Edison's first modest electric lamp, of the death of Baron Auer von Welsbach who, among other things, made the gas light of yesteryear practicable.

It was also the year when physical chemists, breathing hard on the trail of the mathematical physicists leading into the Land of Wave Mechanics, found that the once fundamentally simple gases, oxygen and hydrogen, were, after all, only mixtures of isotopes.

It was the year when the Bureau of Standards announced the evolution of a self-extinguishing cigarette and a fire-proof match, when the stock market crashed, and even coal was made blue.

Fag ends of cigarettes and matches discarded by smokers, it is asserted, cause an annual loss in the United States of \$90,000,000. Almost any concern would authorize its research laboratory to develop means for reducing such a loss. Whether the countless followers of Sir Walter Raleigh will consent to smoke self-extinguishing cigarettes is another matter, however.

The two greatest achievements of 1929 in the chemistry of life processes were the isolation of a toxic sugar produced by the tubercle bacillus and the synthesis of the respiration ferment.

The deadly polysaccharide was isolated by Treat B. Johnson and R. J. Anderson of Yale University, from bacilli grown by Parke Davis and Company and the H. K. Mulford Company. W. C. White of the Hygienic Laboratory of the U. S. Public Health Service tested the sugar and found that it immediately killed tubercular animals and had a noticeable effect upon healthy ones.

To Hans Fischer, of Munich, goes the credit for the synthesis of the respiration ferment, a haemin. This synthesis is classed as one of the most important contributions ever made to the field of biochemistry.

The problem of post-operation, respiratory complications and in some instances pneumonia due to the presence of peroxide or aldehyde in ether used for anesthesia has come to the front during the past year.

While ether for hospital use is prepared with scrupulous care, and extensive work has been done on antioxidants and containers, a considerable quantity has been seized as unfit for use owing to deterioration. Analysis just preceding use rather than on purchase has been suggested as customary hospital procedure.

During the year the suitability of ethylocaine borate for local anesthesia was demonstrated by extensive experiments at the dental school of Northwestern University, ethylene oxide was found to serve as an excellent fumigant against insect pests, and it was discovered that the sodium salt of malic acid may be substituted for sodium chloride in the diet of people suffering from high blood pressure, dropsy, or Bright's disease.

The Graf Zeppelin, it is pointed out, was not exclusively a chemical triumph, yet it is doubtful if it could have circumnavigated the globe without the help of various obscure persons in laboratories and plants.

These obscure persons fueled it with ethane derived from natural gas for its first return trip to Germany from America. Later, when the Graf Zeppelin set out from Tokyo for its trans-Pacific flight, its fuel bunkers contained Pyrofax mixed with hydrogen; the last leg of the journey

was made with a mixture of Pyrofax and natural gas.

Nor was Edison's electric light entirely a chemical dream come true. Nevertheless a great deal of chemistry seemed to have inextricably merged into its history by the time Henry Ford staged its fiftieth anniversary in Dearborn for his old friend, and brought Einstein into a million American homes through a barrage of intercontinental static in the first international broadcast of its kind.

On the other hand, Bonhoeffer, demonstrating the existence of parahydrogen to an amphitheater of cheering chemists at Minneapolis, seemed to be dealing only obliquely with chemistry as it used to be known, while Glauque and Johnston determining the existence of an oxygen molecule containing atoms of different atomic weight, would have been crucified as heretics by the chemical fundamentalists of a previous generation.

A contemporary bidding for fame in the fair field of modern alchemy appar-

ently must have a triple personality, and be not only a chemist but a mathematician and a physicist as well.

The tariff played a decisive role in the chemical industry in 1929, but principally as a disturbing element, the journal complains, characterizing attacks in the Senate upon the chemical industry as unjustifiable.

Final figures will show an increase in chemical exports and imports. Organized effort to promote safety in the chemical industry produced constructive results. Significant advances were made in the development of processes and equipment and in the utilization of products.

Several important movements toward co-operation in the industries, international gatherings of scientists, establishment of new research laboratories, and the continuous growth of the American Chemical Society, which with 17,457 members, has become the largest professional organization in the world, are cited as other outstanding developments.

CATHODE RAYS DETECT JEWELS

Synthetic sapphires can be detected readily from the natural stones by means of the cathode-ray tube. The use of the tube in this work is the first commercial application of the apparatus which was developed in the research laboratory of the General Electric Company by Dr. W. D. Coolidge about four years ago.

Sapphires, next to diamonds in hardness, are used by the company at the rate of more than a million and a half a year as jewels for bearings in meters and other delicate electrical instruments.

Trays of sapphires, both natural and synthetic, are exposed in a dark room to the powerful rays of the tube for a few seconds. All glow or radiate colors while exposed to the rays, but when the rays are turned off, the natural stones cease to glow whereas the synthetic stones continue to glow.

In addition to sorting the natural from the synthetic sapphires, the rays also help

determine where both the natural or factory-made gems come from, an important advantage according to engineers.

"Should sapphires from Montana be mixed with stones from Australia, we could find this out with the cathode rays," B. W. St. Clair, of the company's standardizing laboratory at Lynn, Mass., explained. "In the case of synthetic stones, in most cases we can determine which factory made them by the different hue of the glow while the rays are on.

"We have one particular kind of natural sapphire which does not glow at all. In this case, the lack of glow under the rays immediately tells us its origin."

Tests have been made with diamonds and it has been found that synthetic stones turn decidedly brown when placed in the rays, whereas there is no change in natural stones. However, these tests have been but meager and no definite conclusions have been reached.

THE YEAR IN CHEMISTRY AND PHYSICS

The past year has been unusually eventful in scientific progress and in several of the sciences, particularly in Cosmology, Physics and Chemistry, discoveries of a startling, even revolutionizing character were made. The most remarkable discovery in Chemistry, clearly proving the dual nature of Hydrogen, although probably of no practical value, is, theoretically, of the greatest importance, as it upsets many heretofore accepted theories concerning the atomic structure of matter and throws a startling light on the fundamentals of the atomic theory, which heretofore were unknown and but scarcely suspected.

THE DUAL NATURE OF HYDROGEN

Hydrogen, which was discovered and recognized as an element by Cavendish in 1766, has ever since played an important part in Chemistry. That it was an element, was universally accepted, as it was found impossible to split it into any component parts. As the science of Chemistry progressed, a closer study of the structure of the known elements was undertaken and in 1802 Dalton, a schoolmaster in Manchester, originated the atomic theory in its most primitive form. Since then the atomic theory has passed through many stages of evolution, especially after the epochal discovery of Radium and radio-activity.

But, in spite of the numerous changes through which the atomic theory passed during its gradual evolution, hydrogen continued to hold its position as an element, in fact, as the element with the simplest structure, for more than 150 years. During the last ten years, however, the situation was greatly changed, principally as the result of remarkable advances in physics, which made it possible to get a clearer understanding of the nature, relationship and effects of all physical forces, which, as has been learned since, constitute determining factors in the structure and chemical characteristics of matter.

It was in 1927, that two German chemists, W. Heisenberg and F. Hand, while studying the spectrum of Hydrogen, discovered certain peculiar variations of the lines of the spectrum, which led them to the belief that there existed two kinds of Hydrogen. Basing their calculations on

the theory of wave mechanics worked out by Schroedinger, the German physicist, they came to the conclusion, that, theoretically, two kinds of Hydrogen molecules are possible—one, in which the two atoms forming the molecule rotate in the same direction, and another, in which the two atoms rotate in opposite directions. They named the Hydrogen, consisting of molecules, the atoms of which rotate in the same direction, Ortho-hydrogen, that consisting of molecules, the atoms of which rotate in opposite directions, Para-hydrogen.

Several years before, A. Eucken, while studying the physical characteristics of Hydrogen, discovered, that at very low temperatures the specific temperature of Hydrogen becomes surprisingly low, a phenomenon for which at that time no explanation could be given. In 1928, D. M. Dennison suggested as an explanation of that phenomenon, that it was due to the dual nature of the molecules of Hydrogen. He came to the conclusion, that above 200 degrees abs., the proportion of Para-hydrogen: Ortho-hydrogen in ordinary Hydrogen was about 1:3, while below that temperature the proportion changed in favor of Para-hydrogen. Dennison reached this conclusion not by experimental methods, but merely by theoretical calculations.

About one year later the correctness of Dennison's conclusions was verified by experimental proofs by two pairs of investigators, A. Eucken and K. Hiller in Breslau and K. F. Bonhoeffer and P. Hartek in Berlin-Dahlem. Both pairs of investigators were trying by experiments to ascertain, whether the proportion of Para- to Ortho- hydrogen as it existed in Hydrogen under normal conditions, could be changed in favor of one of the other. It was found, that under high pressure, at -185 degrees, the temperature of liquid air, the proportion of Para-hydrogen could be materially increased, while at normal pressure that was not the case. Bonhoeffer and Hartek succeeded, by lowering the temperature of normal Hydrogen to -233 degrees, the temperature of liquid Hydrogen, and by using vegetable charcoal as catalyst, to expedite the reaction, to increase the proportion be-

tween Para- and Ortho- hydrogen to 99 to 1. A spectroscopic examination showed that the spectrum of Para-hydrogen differed strikingly from that of normal Hydrogen by showing strong lines where the ordinary hydrogen shows weak lines and vice versa. No difference in the chemical action of the two kinds of hydrogen has been observed so far.

ATOMIC AND MOLECULAR STRUCTURE

The theories in regard to the structure of atoms and that of molecules have passed through a great many radical changes since their original conception. Of course, that is not surprising, if we consider the fact that, in the beginning, all interpretations of the composition of matter were based upon a purely empirically materialistic foundation. With the gradual progress in chemistry as well as in physics came a clearer understanding of the close relationship between the two sciences, which became more convincing from year to year, until the leading thinkers in both sciences began to realize that these two sciences were inseparable.

Then began the period of closer collaboration of the two sciences and with it an increasing rapidity of progress in both. Spectroscopy, the astonishing perfection of methods and instruments for exact observations and measurements, the discovery of ways and means for producing and measuring with accuracy extremely high pressures, high and low temperatures, electrical currents, etc., the discovery and careful study of various emanations, rays, etc., as the result of the discovery of Radium and radio-activity, led to heretofore unknown fields in physics and chemistry. Restlessly the students of both sciences devoted themselves to the enormous task before them and, within an almost incredibly short time, many important achievements were obtained, among them Planck's quantum theory, De Broglie's and Schroedinger's wave mechanics, the theory of isotopy and a number of others, which eventually opened the way to a clearer understanding of the atomic structure of matter.

The conception of the atom, which formerly had been rather vague and uncertain, has become quite definite. Although it is far more complicated, it rests upon a physical and mathematical basis, the exact-

ness of which has already made it possible to work out by mere calculation a number of theories which were later proved to be correct by actual tests.

All elements are now considered to be built up of atoms, but, while under normal conditions all atoms of an element are alike in structure, they differ from the atoms of any other element. Each atom, regardless of which element, consists of a nucleus and one or more electrons. The number of electrons varies between 1, in the hydrogen atom, and 92 in the uranium atom. According to the system evolved by Moseley the elements are now arranged numerically according to their atomic number, which corresponds with the number of electrons in each atom of the respective element. The electrons carry negative electric charges, while the nuclei carry positive electric charges, which balance the electric charges of their electrons.

The mass of the nucleus varies with the element and is invariably greater than that of the electrons. In the case of hydrogen, for instance, the mass of the electron is equal to only one-1840th of the mass of the hydrogen atom. It has been calculated that one molecule of hydrogen weighs

$$\frac{2.016}{6.06 \times 10^{23}} = 3.32 \times 10^{-24} \text{ gram. One}$$

cubic centimeter of hydrogen or of any other gaseous element, at zero temperature and 760 mm. pressure, will contain 27.10^{18} , amounting to 27 trillions of molecules.

Atoms, in a normal state, are electrically balanced, but may be changed into electrically positive or negative ions. By the loss of one or more electrons they become positive, by the addition of one or more electrons they become negative. These changes may occur through different influences. Positive ions of great velocity originate at the radioactive disintegration of certain elements and are known as alpha particles, or as helium atoms with doubly positive charges.

Variations from the normal atomic weight are found among many elements, particularly among those of radioactive character. They are known as isotopes and present a complicated and still unsolved problem of theoretical chemistry. Among

the radioactive elements alone more than forty isotopes are known.

Although there are still a great many things to be learned and explained about some of the intricate details of the atomic theory, as it now stands, some physicists have recently advanced some new theories, the correctness of which would undoubtedly upset many of the still unproved, but apparently well supported theories about the atomic structure of the elements. One of these new ideas is, that nuclei and electrons are not the fundamental units of the atoms, but that both are divided into even more minute components, the exact nature of which is not yet clearly pictured.

Many years ago, up to the close of the 17th century, the belief in the possibility of transmuting other metals into silver or gold was generally accepted by scientists and others, but soon thereafter it was almost completely abandoned and the few remaining believers in transmutation were considered either as gullible ignoramuses or as scheming adventurers. Strange to relate, present day scientists no longer doubt the possibility of a transmutation of one element into another. Since the discovery of Radium and radioactivity and in the course of the investigation of these subjects it was learned that such transmutations, like, for example that of uranium into lead, have been going on for many millions of years on our planet, though at an extremely slow rate of speed. Although this discovery has established the fact that such transmutation is possible, it has not led to a revival of alchemy, but has furnished science with a much needed and comparatively exact method of estimating the age of the earth. It has also opened a way for entering more deeply into the study and understanding of the atomic and molecular structure of matter and of the intricate processes connected with it.

Another idea, that of a primary, fundamental substance, from which all matter is built up, has also been revived. In 1815 Prout expressed the idea that all heavier atoms were built up of hydrogen atoms. His suggestion was not accepted by other physicists and chemists and was soon completely abandoned. Now, however, the discovery that the hydrogen nucleus may be considered as one of the component parts of the nuclei of other, heavier elements, has revived Prout's idea and it is accepted

by many distinguished scientists who have devoted themselves particularly to the study of atomic structure. F. E. Johnston, a noted American scientist, has made the statement that he had come to the definite conclusion, "that the hydrogen atom is the prototype of the atoms of all other elements and that atoms are synchronous motor-generators belonging to an adiabatic invariant system."

He asserted that he had no great difficulty "in determining the general structure of the key elements, that is, helium, the inert gases—neon, argon and xenon—and mercury, which corresponds to radon in structure." He admitted, however, that there are still many puzzling problems connected with atomic structure, which are awaiting a satisfactory solution.

Since the discovery and experimental demonstration of the fact that hydrogen is really a mixture of two modifications, ortho- and para-hydrogen, E. Justi, a German physicist, connected with the Physico-technical Institute at Charlottenburg, has discovered and demonstrated that nitrogen is also a mixture of two modifications of different structure, which he has named ortho- and para-nitrogen. It was found, that the para-nitrogen is far less constant than para-hydrogen and changes back to ordinary normal nitrogen in about four days. All efforts to discover a similar duality in oxygen have been futile so far.

Physicists and chemists all over the world are, naturally, greatly interested in the study of atomic structure and devote much of their time to investigations, in the hope of finding the solution of some of the problems which make a thorough and clear understanding of the fundamentals impossible. The result is, that from time to time discoveries are made, which may eventually be of great value when their real meaning is fully understood.

Before a gathering of scientists at the Franklin Institute, Philadelphia, Prof. G. P. Thomson, of the University of Aberdeen, Scotland, recently connected with Cornell University, delivered a lecture and demonstrated by experiment an interesting discovery he had made about electrons. In the course of his experiments with "free" electrons, that is, free from atomic constraint and moving through un-

obstructed space, Prof. Thomson had observed that these electrons presented a peculiar appearance. They looked somewhat like spiders with numerous legs or tentacles extending in every direction and seemed much larger than any electron, normally connected with an atom, could be. Whenever one of the electric tentacles struck an object, it diverted the course of the electron, but apparently without diminishing its velocity. Yet, rejoining the atom, the electron drew in its tentacles and again became a comparatively minute satellite of the atom. Dr. Thomson declared that the orthodox physicist's conception of electrons as mere particles would have to be abandoned.

Two eminent physicists, Dr. G. Breit and Dr. M. A. Truve, connected with the Department of Terrestrial Magnetism of the Carnegie Institution in Washington, D. C., have recently succeeded in developing an apparatus capable of producing 5,200,000 volts and they are confident that even higher voltages can be obtained by the method they have developed. Their object is to use that enormous electric power in their efforts to learn more about the fundamental structure of matter, by breaking up atoms and to get a deeper insight into the nature of magnetism and the phenomena of terrestrial magnetism and terrestrial electricity.

THE DISCOVERY OF DURIMUM

Dr. Hal T. Beans, professor of chemistry at Columbia University, together with Dr. Louis Hammett and Dr. George H. Walden, Jr., also of the chemistry department of Columbia, have discovered a new chemical composition, which promises to be very useful in various industries, hence of great practical value.

According to Dr. Beans' description, the substance, which has been named "Durium," is a synthetic resin in liquid form. When subjected to heat, it is transformed into an insoluble, infusible solid, which combines hardness and flexibility to a remarkable degree. A thin film of it is so hard that it cannot easily be scratched or even broken with a hammer, yet so flexible that it can be bent like paper. It can be produced very cheaply and, owing to the rapidity with which it hardens, it can be used in stamping operations to great advantage. For example, phonograph rec-

ords and talking picture disks, which are pressed from metal dies, can be stamped in durium with the speed of a printing press.

OXYGEN THE PRINCIPAL COMPONENT OF OUR WORLD

In a discourse before the Royal Institution, Sir William Bragg, the noted English scientist, made some interesting statements about the important position which oxygen holds among the elements of which our world is consisting. He pointed to the peculiar fact that in nature certain atoms, certain molecules and certain ways of combining molecules are extensively used, while other atoms, molecules and combinations are but seldom employed.

He mentioned, as an example, that half the world of which we have knowledge is made of oxygen; silicon is used to the extent of 27 per cent, aluminum 8 per cent, while iron and a few other elements make up most of the remainder. The remaining eighty or more elements of the ninety-two do not represent more than two per cent together. As to molecules, the seas that cover the larger part of the earth's surface, give to the water molecule H_2O a large majority over all others.

In his recent work on the silicates, Sir Wm. Bragg and his collaborators showed, that the great bulk of the earth's crust consists of a piling together of oxygen atoms cemented to other atoms, principally of silicon, aluminum, iron or magnesium. Sometimes the piling is of the simplest character and seems to depend for the most part on considerations of space to be occupied. At other times, as in quartz, more complicated structures are framed, in order that the directional qualities of the mutual attractions between silicon and oxygen may be satisfied.

THE VELOCITY OF CHEMICAL REACTIONS

In a communication to "Science"—Vol. LXX, No. 1822, T. W. Evans and W. M. Dehn, connected with the chemistry department of the University of Washington, in speaking of the velocity of chemical reactions, explained in an interesting way the difficulties of obtaining exact data for speed calculations, due to the fact that the absolute time required for the transformation of individual molecules cannot be estimated, because there are

very few exact methods of studying intermolecular mechanics and dynamics. In the case of explosions, however, data are available for the estimation of the time required for the reaction to proceed from molecule to molecule.

As an example they selected nitroglycerine, in which, as has been ascertained, the explosion wave travels at the rate of five miles a second through the mass. The molecular weight of nitroglycerine is 227.1 and its density 1.6, giving a molecular volume of 141.9 cc. Assuming this volume of nitroglycerine to be in the form of a cube, calculations will show that each edge will contain $1,622 \times 10^7$ molecules per linear centimeter. A chain of nitroglycerine molecules five miles long, spaced as they are in the liquid, would contain 1.305×10^{13} molecules. Since the reaction proceeds from the first of these to the last in one second, the time required for the explosion to pass from molecule to the next molecule would be 7.661×10^{-14} seconds. That means, that 414,000 years bear the same relation to one second, that one second bears to the time between successive explosions from one molecule to the next, which includes not only the time required for the explosion of each individual molecule, but also the time required for the initiation of the next molecule, through a transfer of energy. It is impossible to estimate the relative times required for these two processes.

AT LAST A CHLORINE SPECTRUM OBTAINED

Chlorine has been known as one of the gaseous elements since 1774, when it was discovered and isolated by Scheele, but, strange to say, it had been impossible until recently to obtain a complete and satisfactory record of its spectrum. That was due to the fact that almost immediately after the electric discharges in the tube containing the chlorine were begun, the chlorine combined with the hot metal of the electrodes, making it impossible to get a clear spectrum.

Recently, however, experimenters in the laboratory of the U. S. Bureau of Standards have succeeded in overcoming this difficulty by an ingenious arrangement by which the required quantity of chlorine in the tube is maintained by letting a chlorine generator, connected by a small

tube with the discharge tube, replenish the chlorine lost by its combination with the electrodes metal.

It was found that the spectrum of chlorine extends from the still visible section of the violet part of the spectrum to the no longer visible infra-red part. A careful study of the first complete spectrum of chlorine thus obtained proved beyond doubt the fallacy of the belief that certain of the Fraunhofer lines in the spectrum of the Sun indicated the presence of chlorine in the atmosphere of the solar body.

OTHER INTERESTING DISCOVERIES

A new kind of baking powder, which consists of a mixture of starch with a rather complicated organic chemical compound, known as acetone-dicarboxylic acid, has recently been originated by Edwin O. Wilg in the chemistry laboratories of the University of Wisconsin. It has the remarkable advantage over all commercially known baking powders, that, although it has the same power of "raising the dough," it completely evaporates during the baking process, without leaving any saline cathartics, like sodium tartrate, Rochelle salt, disodium phosphate, sodium sulfate or aluminum hydroxide, as residue in the bread or cake. The substance evaporates completely in the form of carbon dioxide and acetone and leaves only the starch, which was added merely to simplify the dosage for domestic use. The keeping power of the new baking powder is said to be equal to that of any other commercial baking powder.

A very promising new sweetening compound, even sweeter than saccharine and 690 times sweeter than sugar, has recently been prepared by Dr. Henry Gilman and J. B. Dickey of the department of organic chemistry at the Iowa State College, from waste products of corn. The substance is the *syn*-isomer of 5-benzyl-2-furfural-doxime. Like saccharine, this compound is not easily soluble in water, this difficulty may be overcome as in the case of saccharine, by combining it with an easily soluble sodium salt. The physiological action of the new sweetener has not yet been definitely ascertained, but investigations in that direction are being made.

Thomas Midgley, Jr., the developer of ethyl gasoline, and Dr. A. L. Henne, a

Belgian chemist, have recently carried on experiments in one of the laboratories of a large electric refrigerator company at Dayton, Ohio, as the result of which they produced a new gas for the coils of electric refrigerators, which in many ways seems to be superior to those heretofore used for that purpose. It is neither poisonous nor inflammable. It is made of carbon tetrachloride and antimony fluoride.

S. F. Acree and a number of scientific and technical collaborators connected with the U. S. Bureau of Standards have worked out a method of producing Xylose, a sugar, similar in chemical composition to glucose, lactose and other food sugars, from cottonseed hull bran on a large scale. It is believed, that now, since the cost of xylose has been greatly reduced, it will play an important role in various industries. It is not a sweet as cane or beet sugar, but may be used as a cheaper substitute for these sugars, especially for sweetening food for diabetics, who cannot tolerate the ordinary kinds of sugar, while xylose is absolutely harmless to such persons. Xylose may be used for many other purposes to great advantage. It may be fermented into alcohol, acetone, lactic and acetic acid, may be turned into a basis for dyestuffs and food colors and may also be transformed into an explosive, similar to guncotton.

An aid in the investigation of the atomic structure of molecules was developed by Prof. Debye of Leipzig, which has led to interesting and highly impor-

tant results. As it is impossible to see a molecule even with the most powerful microscope, either with the aid of sunlight or any artificial light, some other method had to be used. Prof. Debye used Roentgen rays for that purpose with remarkable success, obtaining, not photographic magnifications, but a network of lines caused by the deflection of the rays through the interference of the atomic structure of the molecules. By this method it was, for instance, clearly shown, how a molecule of Carbon Tetrachloride was constructed, which consists of one atom of carbon and four atoms of chlorine. The carbon atom occupies the center of a pyramid formed by four equilateral triangles, while each of the four points where the angles of the triangles meet, is occupied by one of the chlorine atoms. It was even possible to calculate the nearest distance between two chlorine atoms, which was found to be 2.99 ten-millionths of one millimeter.

At this year's annual convention of the American Chemical Society Dr. C. S. Pigot, of the Carnegie Geophysical Laboratory in Washington, D. C., read an interesting paper about the methods employed in analyzing samples of uranium ores found in different locations, for the purpose of estimating the age of our planet. He stated, that the analysis of the samples available varied, but that according to the results obtained from one of the samples, the age of the earth is now estimated at about 1,645,000,000 years.—*E. Welleck.*

INFRA-RED RAYS

Infra-red rays are nothing but heat. A stove, a radiator, a hot brick, a red hot iron, a bonfire—these and many other things give off infra-red rays. There has been much advertising of the kind that makes people think that infra-red rays are something rare and new. The largest source of them is the sun, which is not very new. The term "infra-red" has been used by scientists for over 100 years. It means simply heat rays.

A 200 watt lamp gives off much infra-red. So does any lamp, as it is impossible to make light without at the same time making heat.

All this does not mean infra-red rays are of no value. Quite the contrary, heat rays are very good for relieving pain, as any mother knows, and those that come from a lamp penetrate farther than those from a hot compress. Advertising that hints that the infra-red rays are something new and different is not accurate.

RADIUM FROM KATANGA

The first explorers of darkest Africa, Stanley, Livingstone, Cameron, to say nothing of Trader Horn, have glimpsed some of the riches of the equatorial west coast, penetrating as far inland as they could up the jungle bordered rivers of that mysterious region which is now the Belgian Congo, and all predicted a great future for the uncharted hinterland beyond and southward. Stanley especially was struck with the peculiar characteristics of the soil and the animal life.

King Leopold II of Belgium was so greatly impressed with the tales of Livingstone and Stanley that he organized the first expedition in 1877 under the leadership of Stanley. It was not until 1890 that systematic and strongly organized expeditions penetrated to the very heart of the continent and their discoveries under Delcommune, Le Marinel, Bia and Francqui may truly be said to have opened up the era of Belgium's economic rebirth. The exploitation of the Congo began in earnest and, today, the innermost parts of that strange land, known as Katanga, can be reached by modern means of transportation.

Transportation, naturally, was the first concern of the trail blazers. Railway lines are now reaching into the Katanga from the west coast ports of Matadi and Lobito and the east coast ports of Beira and Dar-es-Salam, supplemented wherever possible by river and lake navigation. Last year there were about 11,000 miles of roads and more being built all the time. Regular airplane service has been established between the Port of Boma on the west coast and Elizabethville.

The mining industry of the Congo and the Katanga is the most important financially. The copper mines of the Union Miniere rival those of any other organization in the world. This mining organization has stepped up its production by leaps and bounds, commencing with barely 1000 tons of copper ingots in 1911, to pass the 112,000 ton mark in 1928. Diamond mining has been mounting even more rapidly, with a total of 1,648,000 carats.

In 1928 the Belgian Congo produced 90% of the world's radium. The Katanga

radium mines have given Belgium control of the radium market of the world.

The first four grams of radium, produced in 1921, were placed at the disposal of the world's foremost medical institutions and a further two grams were given to the Curie foundation in Paris. A gram of radium is valued at approximately \$70,000.

The scheme of organizing the exploitation of the mineral resources of Katanga was a formidable task. Means of transportation were meager and precarious. Settlements had to be built, provided with water and sanitation. Swamps had to be drained and highways cut through the jungle. All construction materials had to be chosen after close scrutiny, with an eye to the utmost economic value—maximum durability for weight and cost so as to reduce the burden on transportation as far as possible. Belgium produces the cheapest galvanized sheets in Europe but that wouldn't do.

Great quantities of pure iron in the form of galvanized corrugated sheets, drainage culverts, flumes for water supply and pipe for all purposes have been shipped into the Congo. Many villages were built with walls of galvanized corrugated Ingot Iron and thatched roofs. Pure Iron was more expensive but it was found to give the best service for its weight and initial cost. Numerous mining and smelting plants, too, were sheathed and roofed with this material. Replacement of a defective roof or drainage pipe is costly business when the source of supply is many weeks distant and the cost of transportation sometimes approximates that of the material itself.

From the very outset the whole country has been developed by industrial organizations. The most powerful is the Union Miniere. Central African colonial development cannot be carried on by whites alone. Only natives can furnish labor in such a climate. Native labor is scarce as aboriginal Bantu tribes are few and sparsely settled. It has been necessary to import recruits from Rhodesia and Angola. The operators have endeavored to make the natives' lot as attractive as possible.

The center of the radium mining industry of Katanga is located at Chinkolobwe, where an extraction plant has been constructed at Oolen by the Societe Generale Metallurgique de Hoboken; its capacity is sufficient for the total radium consumption of the world. The output in 1928 was approximately forty grams. The uranium

ores of Katanga are exclusively derivatives of pitchblende; there are several varieties, chiefly recognizable by color—green, yellow, orange, etc. Their content of the precious uranium from which radium is extracted is much higher than that of the carnotite mines of America.—*H. R. Pape in Pure Iron Era.*

RADIUM

With a market value of nearly two million dollars an ounce, radium is by far the most costly commodity ever commercially produced, says the United States Bureau of Mines, Department of Commerce. Unlike other things of exceptional value, such as precious stones, it is sought for utilization rather than aesthetic purposes. A gem is prized for its beauty and rarity, its value is psychological, and its price is not determined by the cost or effort through which it was obtained from nature. The price of radium, however, is a result of its usefulness and the high costs of mining and processing the ores from which it is obtained. Many hundred tons of hand-sorted ore must be treated with expensive chemicals in order to obtain one ounce of radium.

The carnotite ores of Colorado and Utah furnished most of the radium produced for many years. The business was competitive and the profits were not large as compared to other mining and metallurgical operations.

In the Belgian Congo a deposit of extraordinarily high grade ore was found a few years ago, from which a large tonnage of very rich ore has been mined. Other producers of radium have not been able to compete with the Congo product and have gone out of business.

Unlike most other elements it is not possible for radium to occur naturally in a concentrated form. This is because radium constantly changes into other substance and it can exist only as a product of the atomic disintegration of the rare element uranium. The rates at which radium thus "begins and ends" are constant and happen to be so related that only part of radium (by weight) can exist in equilibrium with three million parts of uranium. Consequently, radium is only found associated with uranium minerals, and the ratio of radium to uranium in a

mineral is always 1 to about 3,000,000. Since uranium itself is a rather rare element, the scarcity of radium can be readily imagined. Nearly pure uranium minerals have been mined from the Congo deposit. Yet two hundred tons of this high grade ore contains only one ounce of radium!

The transformations which "make and destroy" radium are due to explosive disruption of the atoms. These continual spontaneous changes produce three distinct types of radiations. Two of these are similar to X-rays and cathode rays respectively. The third and most remarkable "ray" is an electrically charged atom which is discharged with tremendous velocity and destructive power. It is these radiations which give radium and other radioactive elements their unique value. They are utilized in the treatment of cancer and as an activator in luminous paint.

Radium is detected and quantitatively estimated through electrical effects produced by its radiations. The methods used for this purpose are incredibly sensitive, less than one millionth of one millionth of an ounce of radium can be readily detected, and one billionth of an ounce can be quantitatively determined with considerable accuracy.

Many rocks contain sufficient radium to be detected and even measured. Almost any mountain might contain a million dollars worth of radium, but it would cost many times that amount of money to extract and recover the radium from the rock that contains it.

Although the profit on radium from the Congo ore is probably large, no other deposits of radium have yielded exceptional profit to the prospector, miner, or operator, and the public should be wary of speculative mining enterprises based upon ores containing minute quantities of radium.

NEW MATERIAL FOR CRUCIBLES

A natural source of carbon dioxide from take the place of porcelain has been placed on the market, the product of a Holland manufacturer. Weta-material consists of very fine, uniformly distributed carborundum particles with admixed silicates and metals of the iron series, cobalt and nickel, and sinters, after firing in a porcelain kiln, at about 1400 degrees, Centigrade. A pot is obtainable which, without any glazing, is completely watertight. A glowing hot Weta-material crucible can be chilled in cold water without injury. The dark gray

crucible can be used for qualitative and quantitative analyses and on account of its resistance to breakage is especially adapted for work under very high pressures. Weta dishes survive a large number of determinations without cracking due to decided changes of temperature, knocks, or blows. Tubes can also be produced from Weta-material for use in the manufacturing plant. Weta-material ranks somewhat better than porcelain crucibles from the state porcelain factory.

LITHIUM

Lithium, the metal, is the lightest known solid. It is only a little more than half as heavy as water; light enough to float on ether or the lightest gasoline. Cork and balsa wood appear to be lighter than lithium because they contain pores filled with air.

The element lithium is very widely distributed, being found in traces in almost all minerals, but only in a very few is it present in amounts great enough to serve as ores.

The metal has most remarkable chemical activity of a type to make it useful as a "scavenger" in purifying metals. It is said to be able to remove carbon, sulfur, phosphorus, oxygen, nitrogen and other impurities from alloys and pure metals. It is even claimed that if lithium is melted in an iron vessel, the latter becomes so porous by absorption of the foreign constituents by the lithium, that the lithium trickles through it. Also, that when lithium is melted in a glass or quartz vessel, the lithium reduces the silica to silicon, causing the container to crack.

LITHIUM ALLOYS

A few hundredths of a per cent of lithium, added to aluminum or its alloys, is said to produce a degree of hardness not otherwise obtainable. Such an alloy is "Skleron." A small fraction of a per cent

of lithium added to lead makes a suitable bearing metal. This is the "Bahnmittel" (railroad metal) extensively used on German railways.

The pure metal is very unstable in the air and causes water to decompose at ordinary temperatures. For shipment, the metal is best sealed into tin cans from which the air is removed.

When heated to just above its melting point, 365° F., lithium burns with a dazzling white flame. Its salts, however, color flames a brilliant cherry red. Lithium salts were long but erroneously supposed to be valuable in ridding the system of uric acid, and many thousands of dollars have been spent by rheumatic patients for "lithia waters," the curative powers of which were probably negligible. A fair sized use for lithium salts is in the Edison storage battery, where a valuable service is performed in increasing the electrical capacity of the cells.

Almost simultaneously large scale processes for the production of lithium have been developed recently in the United States and in Germany. A cost of \$25 per pound in quantity has been mentioned and if this price can be bettered or even maintained in continued operation we may look for many new and interesting commercial applications.—*Industrial Bulletin of Arthur D. Little, Inc.*

SODIUM

NOW CHEAP AS IRON

If you had to fill a cubic foot of space with some metal, which metal would cost least? Iron, maybe; but, if as much as a car load were bought, the now rare and very active sodium would be a few cents cheaper, a little less than \$11.50 per cubic foot.

Revelation of the fact that sodium, the metal of extreme purity, remarkable chemical activity, and low electrical resistance, costs so little by volume is made in a comparison of prices of metals in a recent issue of "Metals and Alloys."

Nickel is the most expensive common metal by the cubic foot, that volume costing \$192.50. The same measure of tin sells commercially for \$143.75; copper, \$72.50; aluminum, \$39.50; lead, \$39; antimony, \$31.50; zinc, \$22; and ingot iron and sodium, \$11.50.

Although sodium is now as cheap as iron, if more uses for it were found it might be produced in quantity for a third the present cost. Its occurrence, in close chemical combinations with other elements is common. Electrical decomposition is necessary to separate it.

Unlike most metals, sodium is so active chemically that to be kept pure it is immersed in kerosene. In air a film of oxide immediately forms on its surface. It is slightly lighter than water and melts a trifle below the boiling point of water.

In spite of the fact that sodium cannot be strung from pole to pole and, even if it could, it would be quickly eaten away by the oxygen of the air, it might actually be used as a much cheaper and more efficient conductor of electricity than copper, "Metals and Alloys" speculates. A sodium conductor need be only a third the weight of a copper conductor to carry the same electricity, though it would be three times as large. At prices for sodium which would prevail if such conductors came into use, it would cost only a fraction as much as the equivalent copper.

If we filled a thin copper or austenitic stainless steel tube, strong enough to carry the load, with sodium, and could make provision to avoid difficulties from the high coefficient of expansion of sodium, from the likelihood that it would creep down into the sag of the cable if we left space inside the tube for expansion, and from the danger that would ensue if such a conductor did not break, and could work out the problem of making joints and connections, we should have a cheaper conductor than either solid copper or aluminum. Crazier things have been done.

Sodium is now used chiefly as a modifier in aluminum-silicon alloys and as a hardener for lead. The chemist makes it 99.9 per cent pure; certainly the metallurgist can find more uses for such a metal.

INDIUM

The curiosity metal, indium, only about a pound of which has been isolated from its ores, is produced 99.9 per cent. pure by electrolysis. Although it is very rare and what little there is of it brings for experimental purposes about six times as much as platinum, scientists are hopeful that a use will be found for its peculiar proper-

ties. It melts at a much lower temperature than tin and is very soft and ductile.

Electrolysis separates it from the residue of such ores as iron, aluminum, titanium and silicon, where it is found in small quantities, L. R. Westbrook, of Cleveland, told the American Electrochemical Society.

—*Science Service.*

ALUMINUM AND ITS ALLOYS

A CHEMICAL CURIOSITY FORTY-THREE YEARS AGO

Inventions are not all made in woodsheds, although it seems rather a logical place for a shop. Given a shop and an inquisitive mind, who knows what may happen? There is, however, one woodshed which Mr. Ford will never have for his Dearborn collection, although he uses large quantities of the product that was born there. Unfortunately, this particular wood shed in Oberlin, Ohio, will also never be marked by a tablet, as it has been removed, but there is one on the house which adjoined it that reads: "In This

College, Thus Making Available for Industry a Metal Long Known but Little Used." The tablet tersely describes the invention of a process vitally necessary for the commercial production of one of our most useful metals, particularly when alloyed.

Aluminum was separated from its chloride in 1825 by Oersted. Wöhler continued the Danish scientist's experiments but it remained for the French chemist, St. Claire Deville, to produce the first aluminum commercially. This was approximately 25 years after Oersted's discovery. In 1852 the metal was worth 545 dollars a pound but in five years the price had dropped to 27 dollars a pound. Thirty years later an Oberlin College student was destined to shake the metallurgical world with an epoch-making discovery and in a short time thereafter aluminum sold for two dollars a pound in 1000-pound lots, a remarkable decrease.

Professor Jewett, of Oberlin College, was lecturing one day and said that if anyone should invent a process by which aluminum could be made on a commercial scale that he would not only be a benefactor to the world but would amass a fortune as well. Charles Hall turned to a classmate and said, "I'm going for that metal." Six months later he came into Professor Jewett's office and said: "Professor, I've got it!" In his hand were little globules of aluminum. Inventor at the age of 23, this young man had carved his way to fame and fortune. A month or two later a French chemist, Heroult, of the same age, made the same discovery independently. On the occasion of the award of the "Perkin Medal" to Hall in 1911, Heroult crossed the Atlantic to congratulate him.

A commercial plant was established in Pittsburgh in 1888 by a company called the Pittsburgh Reduction Company, which was the forerunner of the Aluminum Company of America. The first week's production was 100 pounds and it was kept in a safe, as aluminum was still a more or less semi-precious metal. But nobody wanted the product, so the company



100,000 POUNDS OF ALUMINUM USED IN THIS KOPPERS BUILDING

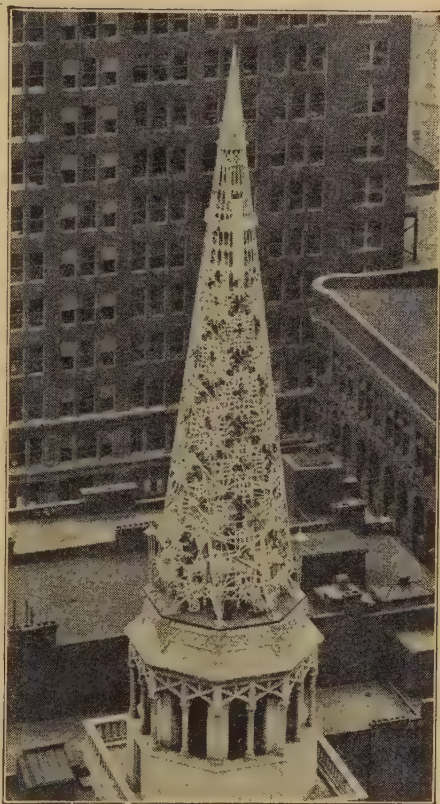
House Charles Martin Hall Discovered the Electrolytic Process of Making Aluminum, February 23, 1886, the Year Following his Graduation from Oberlin

had to go out and make a market. They succeeded so well that the production of aluminum in the United States in 1928 as given by the American Metal Market was 198,414,000 pounds. In 1929 the production showed an increase but definite figures are not yet available. The average price of virgin aluminum has fallen to 24.3 cents per pound, a far cry from something that had to be kept in a safe and which nobody wanted.

It must not be supposed that Hall's invention did not thrive uncontested. The Cowles Electric Smelting and Refining Company, of Lockport, New York, reduced aluminum oxide with carbon in electric furnaces but only a copper-aluminum alloy was produced; it was a high-temperature reaction, and not electrolytic. The late Judge Taft, who was destined to be President and Chief Justice of the Supreme Court, rendered a decision in the United States Circuit Court of Northern Ohio in which he said: "Hall was a pioneer, and is entitled to the advantages which that fact gives him in the patent law." Other litigation followed, but finally all obstructions were swept away. With the cheap water power at Niagara and elsewhere we are able to obtain vast quantities of aluminum, which is gradually entering more and more into our daily life. It is used in our automobiles, airplanes, buildings, locomotives, and kitchens. It is used so much in everything to do with locomotion that it is interesting to note that its use in bicycles really brought aluminum into prominence. The war helped the aluminum industry; the light weight aluminum alloys dictated their use in aeronautical parts and today aluminum propellers, forged under huge air hammers, are standard on many of the finer planes. The dirigible depends largely upon aluminum alloys and aluminum sheet has even been used in place of a fabric as an outer shell for the ship.

Because of the fact that manufacturers did not have uses for the new metal when it was first made commercially available, the Aluminum Company of America was really forced into designing and making all kinds of things such as bottle caps and seals, foil, and so forth, as well as plates, sheets, bars, castings, forgings and articles fabricated from them. The writer well remembers as a boy seeing the Cowles elec-

tric furnaces in "Lower Town" in Lockport, New York. These were under open sheds and it was a puny affair compared with the immense "pot room" at Niagara Falls, where the ingots are now produced.

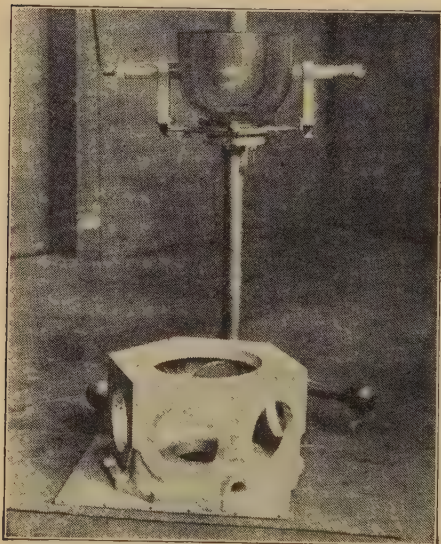


ALUMINUM CHURCH SPIRE

The aluminum comes to the mills and shops in the form of "pigs" or ingots which weigh about 50 pounds. While large quantities of aluminum are used without alloying for consumption in foil, bottle caps, kitchen utensils, and hundreds of other uses, much of the aluminum of commerce is consumed in the form of alloys. The aluminum and the alloying metal, copper for example, are melted under the most precise pyrometric control, and cast into ingots weighing between one and 30 pounds. The alloys thus made are subse-

quently remelted and cast into rolling ingots or castings.

In the case of sheet, tubing, and forgings, the ingots generally weigh between 50 and 300 pounds, but for structural



X-RAY MACHINE FOR LOCATING DEFECTS

shapes these ingots may weigh upward to 3000 pounds.

Aluminum and its alloys are cast in a number of ways—by gravity in sand molds; by gravity in accurately made fixed molds (permanent mold process) and by die casting under great pressure. The alloys can be forged under a steam or air hammer just as are iron and steel; airplane propellers are so forged. Remarkable effects are produced by heat-treating aluminum alloys. The end is to secure the best possible distribution of the alloying element and then to fix it. The heat treatment is conducted in electrical furnaces and steam pressure tanks. Aging of alloys, both natural and artificial, also enters the case, but here we are treading on a metallurgical morass so we had better retreat while there is time. Alloys have been developed which can be forged from one piece without reheating. Strong alloys are also made proof against corrosion. Pure, comparatively weak, aluminum is used as a protective coating over strong aluminum

alloys. Indeed, the results obtained by heat treatment are so peculiar that it is sometimes called "voodoo" treatment by the scornful. The more you see of the processes of manufacture, the more respect you have for the magnificent laboratories which control it all.

Strong aluminum alloys have been developed to supply engineering materials, having mechanical properties comparable with those of steel, and, at the same time, retaining the well-known characteristic properties of the parent metal. Briefly summarized, these include low specific gravity, good resistance to corrosion, high thermal and electrical conductivities, and pleasing appearance. Pure aluminum has a tensile strength only about one sixth that of mild steel but "17ST" has a tensile strength of 55,000 to 63,000 pounds per square inch and a yield point of 30,000 to 40,000 pounds per square inch, fully comparable with low-carbon nickel and carbon steels.

These aluminum alloys are of rather recent development, but they have found immediate application in the aircraft and automotive industries, and their use has rapidly spread to other fields. From the truck and the bus, where the light alloys have already proved their worth, it is only a step to the electric and steam railway car, and this step has already been taken. Here the strong aluminum alloys have replaced steel. Such a substitution is not possible on the basis of first cost alone, even when it is considered that the low specific gravity of these alloys results in a very much lower metal requirement for any given part.

When, however, the saving in power during the life of the assembly is considered, and also the lower maintenance cost resulting from the decreased inertia and vibrational stresses, as well as the increased resistance to corrosion, the advantage of the aluminum alloys becomes apparent. When, however, the strong aluminum alloys are substituted for other non-ferrous alloys, there is frequently an actual saving in metal cost.

Almost at the birth of the automobile industry aluminum was recognized as an important material of construction and the automobile manufacturer is aluminum's largest customer. Aluminum is ideal for truck bodies in that it increases the pay-

load or decreases the dead weight of the truck. Fuel consumption and wear and tear on the chassis are also lessened. Even if an aluminum body costs 600 dollars more, the revenue is increased some 800 dollars a year and the scrapped body can be sold for around 300 dollars. Trolley cars with aluminum bodies are giving excellent service and show the way to increased economies. The Navy's metal-clad dirigible "ZMC-2" not only has an aluminum framework but is enclosed in aluminum sheeting. The use of aluminum in airplanes is almost an old story now. Aluminum is ideal for many parts of the radial motors and forged aluminum propellers are largely used. Outboard marine motors afford a fine field for the use of aluminum. In washing machines, vacuum cleaners, and other household appliances aluminum enters the house as well as via the kitchen. Seals for bottles are made at New Kensington, Pennsylvania, by the hundreds of millions and are used on products packed in various places all over the globe. Aluminum foil is largely used in place of tin foil and can be obtained in all the colors of the rainbow. Aluminum tanks make good oil storage containers and aluminum tank cars carry acetic acid safely. Aluminum furniture has come into its own. An average aluminum chair weighs only about seven pounds.

Aluminum is very successful in the building field. Over 900 aluminum spandrels were used in the Koppers Building in Pittsburgh, while in the new Chrysler Building in New York the spandrels, copings, and sills are of aluminum. Aluminum shingles and cast aluminum ornaments and crests are being largely adopted.

Shingles made of aluminum have many points of excellence due to the inherent properties and qualities of the metal itself. They are wind, water, and weather tight. They are unbreakable and non-inflammable. They are frost proof; they cannot crack nor leak, because they are flexible. They are, of course, non-rusting and are light in weight, thus relieving the roof framing timbers of excess weight. These shingles are laid from the top downwards, so no scaffolding is laid over them and they are not injured by being walked on. Sheets of aluminum have been exposed to the ravages of the elements for over 25 years and at the end of that time they

show no appreciable deterioration. This is worthy of note, when considering various shingle materials for building.

One of the most striking uses of aluminum for architectural purposes will be found in a church in Pittsburgh in the downtown section, surrounded by lofty office buildings. This church is the German Evangelical Protestant Church which is built in a modification of the French Gothic style. The spire is made up of aluminum castings. There are 221 castings used in this striking edifice which towers 259 feet above the level of the street. The spire is octagonal and is 80 feet in height. It rests on a concrete base 179 feet above the street. The crosses on both sides are also made of aluminum and are illuminated at night. The extreme tip of the spire is a single casting weighing 201 pounds. This spire will never have to be painted and it stands out brightly under Pittsburgh's rather trying climate. Aluminum also caps the Washington monument. The capstone weighs 3300 pounds and is finished off by a small pyramid of aluminum 5.6 inches at its base and 8.9 inches high. It weighed 100 ounces; being the "largest piece of this metal ever cast in any country." This was in 1884; recently a 3800-pound base for a Diesel engine was cast.

Aluminum paint is used in many industries. The pigment base is "albron," which is made by stamping pure aluminum into small, flat, and very thin *flakes*, which, when mixed with a suitable oil or varnish vehicle form aluminum paint. These tiny flat flakes overlap one another when applied. They arrange themselves layer on layer much like falling leaves. Thus there is formed a metallic sheath that can be readily washed. One coat will completely hide a black surface.

One more example of the application of strong aluminum alloys, in this case to locomotives, and we are through. It has been found advantageous to provide reciprocating parts of aluminum alloy. Any weight saving in the reciprocating or rotating parts can be put into boiler capacity without increasing the weight on the drivers. The saving in rail hammer is very great.

So here we must take leave of this very light and versatile metal and its useful "hard-boiled" alloys, to mill out new uses in our machine world.

PROTACTINIUM, RAREST METAL

Protactinium, recently isolated by the writer, is a new, strongly radioactive chemical element. It is a metal like radium, but about two times rarer than the latter and, in fact, the rarest metal yet obtained in the world.

Of the great number of radioactive elements found since the splendid discovery of radium and radioactivity by Madame Curie in 1898, protactinium is the only one besides radium which can be obtained in larger amounts. Whereas the other radioactive elements are so extremely rare that most of them cannot be seen even under a microscope, protactinium can be obtained in sufficient quantities to be investigated by the chemist in the same way as the common elements.

The protactinium atom explodes in the same manner and practically just as violently as radium. While the average life of the radium atom is 2500 years, protactinium lasts about twenty times longer; that is, about 50,000 years.

During the explosion of the protactinium atom the alpha particles (helium atoms), electrons and gamma rays are shot off at enormous speeds. An atom of the element actinium is thus formed and it is from this property that protactinium derives its name (*proto*, meaning in Greek "first"). In addition to actinium a whole series of atomic disintegration products is formed, among which is the gas actinium emanation.

Chemically, protactinium is Element 91, called also "ekatantalum," occupying the ninety-first place in the periodic chart of the elements, between the two heaviest metals known, thorium and uranium.

The existence of Element 91 was foretold 60 years ago by the famous Russian scientist D. I. Mendeléeff, when he devised the periodic table of the elements. It was established as a fact in 1917 when Prof. O. Hahn and Prof. L. Meitner in Germany, and simultaneously Frederick Soddy, the distinguished pioneer of radioactivity working in England in collaboration with J. A. Cranston, discovered new alpha rays and proved that they came from a new element which could only be the Element 91, present in great dilution in their material.

During the following 10 years all efforts to obtain and isolate the extremely rare protactinium were unsuccessful, owing to the wrong chemical properties being attributed to it, and until 1927 nobody actually saw it. It was generally thought that Element 91 resembled tantalum, just as radium resembles barium; since the latter are always associated, an attempt was made to isolate protactinium by adding tantalum to the raw material and extracting them together.

In November, 1926, the writer proposed a new theory of the chemical properties of Element 91, pointing out its difference from tantalum. In the spring of 1927 he had the good fortune of obtaining and seeing for the first time protactinium in the form of its pure white oxide, as shown in the illustration. The oxide forms an absolutely white powder with a very high melting point. It shines with a faint glow in the dark, due to the explosions in the atoms.

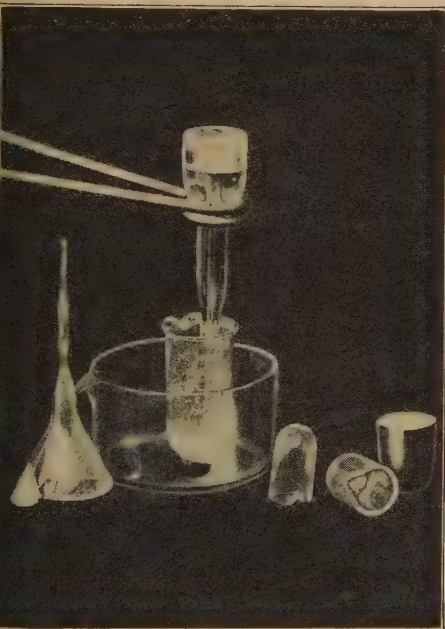
The difference from tantalum, previously predicted, was therefore established as a fact. It was not even necessary to try the separation of protactinium from tantalum, as it occurred by itself.

In 1927 only two milligrams of protactinium were obtained—just about as much as a needle point. As it was necessary to experiment for weeks with the same scarcely visible material, special equipment was devised to analyze, determine the radioactivity, filter, and crystallize minute quantities of matter. In the photographs, as reproduced, the original apparatus used is shown seven eighths natural size.

Very great care had to be taken during the work in order not to lose the extremely valuable material. Once one of the tiny beakers containing the whole available amount of protactinium slipped out of the writer's fingers and only by a lucky chance was an irreparable loss avoided. The experiments were accomplished during the author's stay in Germany, at the splendidly equipped Kaiser Wilhelm Institute of Chemistry, in Berlin.

In nature protactinium always accompanies radium in uranium minerals and ores. These contain for each gram of

radium about 0.6 grams of protactinium. As has already been pointed out, Element 91 is the rarest metal obtained in the world, leaving far behind such rare elements as rhenium, discovered in 1925 by W. and I. Noddack and O. Berg in Ger-



FILTERING APPARATUS— $\frac{7}{8}$ SIZE

many, and illinium, discovered in 1926 by B. S. Hopkins, L. F. Yntema, and J. A. Harris of the University of Illinois.

In the richest uranium minerals Element 91 is found in the fantastic proportion of only 1 part to 10,000,000 parts of ore. It is therefore necessary to work up tons of raw material to get only grams of the new element. A special procedure is employed to detect the presence of Element 91; it is now possible to determine the amount of protactinium with great accuracy even in a dilution of 1 to 2,000,000,000, thanks to special analytical methods worked out at the Shanghai Institute.

While the uranium ore is worked up for radium, the Element 91 accumulates in the insoluble residues which constitute the wastes from radium factories and which

previously had no commercial value. These waste residues contain protactinium in a much greater proportion than the natural uranium material, and therefore they represent at present the best raw material for the production of the new element.

One gram of radium now costs 65,000 dollars and, since Element 91 is rarer, one would think that its production cost would be higher. Yet protactinium would not be nearly so expensive as radium because the radium wastes are cheap, because their protactinium content is higher than that of radium in uranium ore, and because the protactinium extraction process is fairly simple.

For further research on protactinium larger quantities than the two milligrams obtained in 1927 were needed, and in 1928 radium wastes could be worked up in an industrial scale, thanks to the great German "dye trust" (*I. G. Farbenindustrie A. G.*). From half a ton of wastes from the old radium factory in Joachimsthal, Bohemia, which was presented by the government of Czechoslovakia, about 40 milligrams, or one hundredth of an ounce, of protactinium were extracted, under the supervision of the writer, at one of the *I. G. Farbenindustrie's* factories at Ludwigshafen on the Rhine.

The protactinium extraction process is fairly simple—much simpler than the production of radium. This is due to the individual chemical properties of Element 91, which differ very much from any known element. Radium, on the other hand, greatly resembles barium, so that it is difficult to separate the one from the other.

The wastes from radium factories contain large amounts of silica and iron oxides. They are first boiled with concentrated acids, which dissolve all the iron and other soluble oxides, leaving the "silica residue," which contains Element 91. This residue is melted with alkalis and the melt is extracted with water. This dissolves all the silica and leaves a small precipitate, containing the Element 91 in the concentration of 1 to 10,000. The latter is dissolved in dilute acids and from this solution protactinium is separated, together with the metal zirconium, as a phosphate. By a special method, called by the author the "spiral process," Element 91 is separated from zirconium and freed from all other impurities.

The United States and Belgium are the only two countries in the world which can supply the raw material for protactinium production on a large scale. In the wastes of American radium factories which work up the uranium ores from Utah and Colorado, more than 100 grams (.22 pound) of protactinium are stored, an enormous quantity when we consider that the world radium production since the discovery of that element does not amount to more than 350 grams (three quarters of a pound). Belgium produces radium from rich uranium ore imported from her colonies in Africa. The amount of protactiniferous wastes is much smaller than in the United States, but probably of a better quality.

Protactinium is thus a very new scientific baby—and nobody knows what use it will find in the future. Nothing has been done as yet to find an industrial and commercial application for it. Evidently much larger quantities than the small amount which constitutes the whole present world production of this element are needed to start experiments. However, it is not likely that protactinium will replace radium, for the latter produces in a shorter time a larger amount of effective radioactive disintegration products than protactinium.

In medicine, Element 91 ought to find a different application than radium salts, as protactinium compounds behave quite differently in the body of living beings.

Protactinium is the only radioactive element that can be obtained as a metal. It can therefore be formed into sheet and wire and alloyed with other metals. Perhaps on account of this property protactinium will be of some value later on.

One definite advantage which may accrue from the research is the possibility of getting actinium. This element is 2000 times rarer than Element 91. It has therefore never been seen by human eyes, although it already has a practical applica-

tion, in extremely diluted form, in radiotherapeutics, as it is over 100 times as active as radium. Actinium atoms are constantly being born from the mother substance, protactinium, and since the latter is now obtainable in a pure state it is extremely easy to separate the "baby," actinium, from protactinium and prepare it in visible quantities.

Large quantities of Element 91 are required for purely scientific research work. When they shall have been obtained it will be possible to answer many important questions about the chemistry and physics of this element. Then the so-called "actinium riddle" which has bothered scientists for 20 years and which Prof. A. S. Russell of Oxford, a leading British radiologist, recently termed "one of the outstanding problems of radioactivity," will be solved. It is the riddle of the origin of protactinium and the actinium which requires an explanation. Since the protactinium atom dies after having lived 50,000 years, and since our mother earth has existed for many millions of years, the birth of protactinium atoms must take place somewhere and from an unknown mother element of long life.

Certainly anything that will bring us a step further in the science of radioactivity is very important, since it is this science that has furnished a great deal of those fundamental facts on which our present-day conception of matter, the atom and the way it is made, is based. From this point of view the scientific importance of Element 91 is probably greater than any commercial value it may acquire in the future.

The technical obstacles in the way of large-scale extraction from radium wastes have been overcome and it is hoped that the difficulties in organizing a production of larger amounts of protactinium will be solved as soon as possible, so that its many still unknown properties may be studied.—*Dr. Aristid V. Grosse.*

REFINING METALS

ZINC AND COPPER BY THE ELECTROLYTIC PROCESS

"White Coal" was responsible for the selection of the site for the Anaconda Copper Mining Company's electrolytic zinc reduction plant near Great Falls, Montana. The importance of an ample supply of cheap electric power is easily understood, for the plant sometimes demands as much as 64,000 kilowatts, or 85,000 horsepower. The total connected motor load of the 600 alternating- and 182 direct-service motors in service, including the rotary converters and motor-generators, is 102,000 horsepower. In addition to the zinc plant, which is the largest of its kind in the world, the properties include also a large electrolytic copper refinery and a mill for making copper rod and wire.

Transmission lines carrying 110,000 volts transport power from the hydro-electric stations of the Montana Power Company at the Great falls and the Rainbow falls, in the upper Missouri River, supplemented by four 6600-volt transmission lines from the Black Eagle falls station adjacent to the plant. A fourth large hydro-electric plant is now being constructed in the vicinity, at Morony Dam. The most distant of these power sources, at the Great falls, is only seven miles from the plant.

Although the mining region centering at Butte, Montana, has been famous for 25 years as the greatest copper producer of the world, it had its inception as a placer gold mining camp, when gold was discovered in the sands of Silver Bow Creek in 1864. Silver soon became the most sought-for mineral, for valuable silver ores were found in the oxidized parts of quartz veins prominently traceable on the hillsides. The claims staked on these lodes later proved to be enormous producers of copper, as the diggings were carried farther beneath the surface. In 1887 about 290 stamp mills were working the silver ores of the Butte district, but the industry reacted sharply to the sudden drop of silver prices in 1902.

However, the copper industry had already reached its full stride. From 1870 to 1879 claims had been staked covering most of the valuable copper deposits,

although many of them, like the Anaconda claims, were located for silver ore. The copper ore was originally hauled to Corrine, Utah, on the Union Pacific Railroad. After this 400-mile haul, it was transported to eastern plants for treatment. Some of the chalcocite was shipped to Swansea, in Wales.

In 1879 the first successful smelter in Butte was built by the Colorado Smelting Company, greatly stimulating the local production. Several other smelters were constructed within a short time, including the Parrot, Montana Copper, Bell, and Clark's Colusa. The Montana Copper Company established its smelter at Great Falls, 180 miles from Butte, in 1892, under the name Boston and Montana Consolidated Copper and Silver Mining Company. The smelter at Anaconda, about 15 miles from Butte, was started by the Anaconda Copper Mining Company in 1883. In 1902 the "new works" was built across the valley. This plant, the largest non-ferrous smelter in the world, treats about one fourth of all the copper produced in the United States. Its 585-foot smoke-stack is the highest in the world; the Washington Monument could be placed inside of it, and would be completely out of sight.

At Great Falls, the Boston and Montana Company had erected a plant for the production of blister copper, a blast furnace plant for the re-treatment of converter slag, a furnace refinery, and an electrolytic copper refinery. In 1910 the properties of this firm were taken over by the Anaconda Copper Mining Company, and six years later the first electrolytic zinc reduction plant was erected, after years of costly research and experimentation. The present plant produces about 20 percent of the world's total output of zinc. It has a capacity of 335 tons a day, or about 20,000,000 pounds a month, of practically pure zinc.

Metallurgical science wrestled for years to perfect the electrolytic zinc process. No one seems to know who first thought of leaching roasted zinc concentrates with dilute sulfuric acid and recovering the zinc as metal from solutions by electroly-

sis; it had been tried as early as 1883, but the most nearly successful early attempt was made in 1898 at a plant in Australia, erected to treat Broken Hill ores. Aided by the development of the selective floatation process for the preliminary preparation of the ore, and stimulated by high war-time prices for zinc, metallurgists of the Anaconda company developed the process which led to the construction of the plant at Great Falls in 1916. The company has another electrolytic zinc plant in Anaconda. These two Montana plants have a combined output of approximately one million pounds of zinc a day. Other

To convert the zinc concentrates into a product suitable for treatment in the leaching plant, the material is roasted. This process converts the zinc and lead sulfides into the sulfate and oxide forms, expelling the excess sulfur and oxidizing the iron and other metals in the ore. Each of the 14 roasting furnaces has an individual motor for driving a revolving center shaft which is five feet in diameter, brick lined, hollow, and equipped with 26 water-cooled arms. These arms have rables for moving the concentrates from the circumference to the center of the furnace, and vice versa. The furnaces are each 25



CASTING REFINED ZINC INTO 50-POUND SLABS

plants of a similar nature, owned by the Anaconda Copper Mining Company, are located in Idaho, Utah, Australia, Poland, Italy, and Germany. New plants are being built in Illinois, Canada, and Norway.

Flotation concentrates arrive at the Great Falls zinc plant in open-top, hopper-bottom, 50-ton steel cars. After control and umpire samples are taken of the contents of each car, for use in deciding its composition and value, the concentrates are dumped into storage bins. There are 19 of these bins with a total capacity of about 3300 tons. Concentrates of varying composition are blended to give a uniform feed for the roasters.

feet in diameter, consisting of a brick-lined shell with seven hearths inside and an open hearth on top.

The furnace gases pass through a settling chamber before going to the "big stack," which is almost as tall as the one at Anaconda. The dust recovered is returned to the roasters; the total flue dust re-treated averages a little over 15 percent of the weight of the new material treated. Calcine, the product of the roasters, is drawn off in hoppers under the furnaces, transported in four-ton cars to revolving coolers, and then discharged into a 400-ton storage bin for shipment by the local electric train to the zinc leaching plant.

Natural gas is used for firing the furnaces. Each one has two burners which are fired directly into the seventh hearth, eliminating the use of fireboxes. As much as eight million cubic feet of natural gas is used daily in the Great Falls reduction works. The gas is piped from the Kevin-Sunburst oil field, about 100 miles northwest of Great Falls.

In view of the fact that the furnaces have also been fired with pulverized coal and fuel oil, some interesting comparisons are available. Using pulverized coal of about 950 B.T.U., it requires about one seventh of a ton of coal for roasting one ton of concentrates. About 14 gallons of fuel oil, with 18,500 B.T.U., and specific gravity of 0.92, is needed for one ton of concentrates. About 2400 cubic feet of natural gas, of 930 B.T.U., is adequate for roasting the same amount of material.

There are three principal steps in the zinc leaching process: first is a neutral or purification leach; second, the acid or finishing leach, and finally a re-treatment of the residue from the acid leach. In huge open tanks of the Pachuca type, the roasted concentrates mix with an acid solution used previously in the electrolytic tanks. The acid is neutralized in the process, and iron, arsenic, silica, alumina, et cetera, are precipitated.

After passing through a series of Pachuca tanks, the solution discharges into Dorr classifiers for removal of coarse material, and the overflow goes to thickeners for the separation of solids from the solution. The pulp is drawn from the bottom of the thickeners and again treated with the leaching solution in the tanks, after which the thickened pulp goes to Oliver filters. The filtrate is returned with the thickener overflow to the first leach, and the residue cake goes to dryers. After passing through the first set of Dorr thickeners, the overflow goes through a purification system which precipitates the copper and cadmium by agitation with zinc dust. After purification, the leached zinc-bearing solution is pumped into storage tanks, ready for the electrolytic treatment.

According to Mr. Albert A. Wiggin, manager of the Montana Reduction Departments of the Anaconda company, "The successful electrolytic deposition of zinc from a sulfate solution is primarily dependent upon the purity of the solution

fed into the cells." In the leaching and purification processes, no effort is spared to produce a solution entirely free of metals electro-negative to zinc.

Power enters the plant at 110,000 volts, and is stepped down through nine 6100-kilo-volt-ampere, three phase, 60-cycle, water-cooled transformers to 406 volts. This is passed through nine 5800-kilowatt synchronous rotary converters, which yield about 580 volts, direct current, for use in the electrolytic tanks or cells.

In a building 395 feet by 252 feet, zinc is electro-deposited on aluminum sheets suspended in tanks filled with the zinc-bearing solution. Of the 1164 cells, 1152 are continuously in service. These are divided into eight units of 144 cells each. Lead is used wherever there is danger of contaminating the solution, for lining the cells, and also as anodes from which the current flows to the aluminum cathodes. There is no free acid in the solution when it first enters the tanks, which are arranged in cascade form. When the electrolyte leaves the tanks (to be used for leaching roasted concentrates) it contains acid equivalent to one and one half times the amount of zinc removed during the electrolytic process. To cool the tanks, water is circulated through a lead pipe placed beneath the surface of the solution.

Every 24 hours the zinc-coated aluminum cathodes are removed, and the zinc is stripped off. These thin sheets of zinc are stacked in piles and moved on small cars to the melting and casting department. The sheets are dumped into the furnace through a hole in the roof, probably to be melted beneath the surface, for about 150 tons of molten zinc is kept in each of the three gas-fired furnaces. The molten zinc is dipped out of the furnace by means of long-handled ladles suspended from trolleys on overhead I-beams, and is cast into moulds arranged in rows near the furnace. One man can dip and cast into 50-pound slabs about 30 tons of zinc in an eight-hour shift. No practical scheme has been found for improving upon this laborious method of casting, although various mechanical arrangements have been tried.

Atomized zinc, or zinc dust, is made by transferring the molten metal to graphite crucibles tapped or perforated with one-eighth-inch holes. As the molten zinc falls

from these openings it is caught in a jet of compressed air from an atomizing nozzle and is blown into a settling chamber. This product is used in the purification division for removing copper and cadmium from the zinc-bearing solution. Cadmium, by the way, has become an important by-product of the zinc plant, since this metal has come into use for electroplating.

Although the electrolytic zinc plant is the largest of its kind, it is but one of several divisions of the Great Falls Reduction Department. Copper refining operations are conducted on a large scale in

an adjoining plant, where copper from the company's smelter at Anaconda is purified by electrolysis.

From 80 to 90 percent of the finished copper produced here goes to the nearby rod and wire mill. For many years all of the copper produced in the Montana mines went to eastern markets, much of it returning later in manufactured form at greatly increased prices. The establishment of the large wire mill at Great Falls has changed this situation, providing for the far west a convenient and economical source of supply.

ELEMENT 87

With a method so delicate as to detect the presence of a chemical compound when dissolved in ten billion times its own weight of water, Dr. Fred Allison and Edgar J. Murphy, of the physics department of Alabama Polytechnic Institute at Auburn, Alabama, have located the unknown element number 87 in two well-known minerals. They have made a preliminary report of their research in *Physical Review*, the official journal of the American Physical Society.

Lepidolite, a form of mica, and pollucite, a mineral consisting chiefly of the elements caesium, aluminum and silicon, were the substances studied. As the properties of element number 87 are known in a general way, even though it has not yet been discovered, Dr. Allison and his colleague were able to predict its effect. Studies of the substances in four different chemical combinations all showed the effects that should be caused by element 87. This, say the experimenters, "affords evidence of considerable weight for its presence in the sample under test."

The next step will be to extract the element from the minerals, and when this is done it may truly be said to have been

"discovered." Then only one unknown element will be left. According to modern conceptions there are 92 elements, numbered from hydrogen, which is number 1, to uranium, number 92. At present the series has two vacant spaces, one being number 87, to which the name eka-caesium has been tentatively assigned, and which is in the same group as lithium, potassium, rubidium and caesium. The other element is number 85, in the same group as fluorine, chlorine, bromine and iodine, known chemically as halogens.

About seven years ago there were six unknown elements. Then, in 1923, two Danish chemists, Coster and Hevesy, found number 72, which they named hafnium, after the Latin name for their city of Copenhagen. In 1925 Dr. Walter Noddack, at the University of Berlin, with the aid of two assistants, discovered numbers 43 and 75, which he named, respectively, masurium and rhenium. This was followed in 1926 by illinium, number 61, discovered by Dr. B. S. Hopkins, and named after the University of Illinois, with which he was connected. This was the first element discovered by an American. — *Science Service*.

NATURAL CARBON DIOXIDE

A natural source of carbon dioxide from which "Dry-Ice" can be made for use in freight refrigeration in the West is promised from gas wells in Utah and Colorado, says *Food Industries*. The use of natural carbon dioxide has never been attempted previously. Although the supply has been known for some time, no market was apparent until the field for solid carbon dioxide in the shipment of food stuffs assumed its present proportions.

The two gas domes under consideration are said to be controlled by a single group of Western business men holding options on the existing permits. One of the domes is something unique to oil drilling experi-

ence. It is known as the Farnham structure, near Price, Utah. An oil company drilled into it some years ago and found, to the surprise of the promoter, a gas that would not burn. The hole was plugged and the working abandoned. The gas is almost pure CO₂ with helium in non-commercial quantities. In its natural state it is said to meet requirements for purity necessary for refrigeration of foods.

In the well, the gas occurs at a pressure of about 500 pounds per square inch. This must be increased to 1,100 pounds to convert the dioxide into a liquid preliminary to spraying it to form CO₂ snow.

FROZEN FOODS

Recent announcements by some of the leading meat packers and food manufacturers have shown that the actual distribution of frosted meats and other products has begun.

Quick freezing presents a number of advantages both to the producer and to the ultimate consumer. It is effected so rapidly and at so low a temperature that the flesh or vegetable cells are not ruptured by the small ice crystals so formed. Foods so treated can be kept in better condition for a much longer period of time than ordinarily. This factor will tend to make the food products of even the remotest lands available in a thoroughly wholesome condition at the largest centers of population. Some day we may obtain a considerable quantity of our fish from the Antarctic Ocean, and our meats from the Congo—all of them having been quick-frozen at the point of original procurement.

Meats so treated are also available to the consumer in a more sanitary form than at present. Meats will be cut up at

the packing houses into small individual pieces, frosted, wrapped and maintained at a temperature below the freezing point until they are placed in the consumer's hands.

Probably the greatest difficulty which this new process now faces is that of distribution channels. The average retailer is not equipped to handle quick-frozen foods, and cannot become so without considerable expense. Such foods cannot be kept in the ordinary refrigerating apparatus, nor can they be kept with other foods which are held at temperatures above the freezing point. It may very well be that the smaller retailers will not appear in the distribution chain of quick-frozen foods as eventually established. Perhaps the retailing will be in the hands of the larger chain groceries, or it may even be carried on by dealers now in other lines, such as drug stores, as these latter are in many cases more capable of providing the necessary refrigeration than are many of the smaller groceries and food stores.—*Industrial Bulletin, Arthur D. Little, Inc.*

CARBON MONOXIDE POISONING

A special committee appointed by the American Medical Association to consider the cases of poisonous gases in industry has just made its first report which covers particularly the use of carbon monoxide and its dangers. The committee consists of: H. Gideon Wells, M.D., chairman; Yandell Henderson, Ph.D.; Paul Nicholas Leech, Ph.D.; Carey P. McCord, M.D.; and L. R. Thompson, M.D. It is pointed out that poisoning by carbon monoxide gas is one of the hazards of modern life that can never be entirely eliminated because the generation of that gas is associated with the operation of automobiles and stoves, the combustion of wood, and the manufacture of many products. Whenever wood, coal, or petroleum products are burned, carbon monoxide may be a by-product. If a coal fire is lighted and the coal is too deep for air to pass easily, or if the air supply is checked in any way, carbon monoxide may be produced by taking away some oxygen from the carbon dioxide developed in the lower layers.

Manufactured gas in most cities contains about 20 percent of carbon monoxide and burning a flame near a cooking utensil or a pipe containing cold water stops the combustion at its first stage and liberates large amounts of carbon monoxide. Cooks working over stoves are sometimes affected with headaches as a result of inhaling too much carbon monoxide. This danger can be reduced by increasing the distance between the opening of the gas burner and the cooking utensil. The cooking utensil filled with cold water should be just above and not in the visible flame.

The chief source of deaths and poisoning from carbon monoxide is illuminating gas,

and the prevention of such deaths must depend largely on better inspection of devices used in the handling of illuminating gas.

There have been a number of deaths, particularly in the winter months, from the carbon monoxide in automobile exhaust gas. Every year before cold weather begins drivers of cars must be warned again about starting the engine of an automobile before opening the garage doors. For a little while it is more comfortable to have the garage doors shut, but in the same little while the person becomes unconscious from inhaling carbon monoxide and unless he is discovered in time, he will die of the effects. Recent evidence indicates that even in the streets people inhale enough carbon monoxide on some occasions to make them sick. When inhaled, this gas produces headache and nausea, and no one really knows what the effect of repeated intoxication to a mild degree may be if continued over a period of years. Various attempts have been made to develop methods of preventing the exhaust of carbon monoxide from the automobile, but thus far no practically successful method has been developed.

When a person becomes a victim of carbon monoxide poisoning, the first thing to do is to give him immediate artificial respiration. He should also inhale a mixture of oxygen and carbon dioxide until his pulse and temperature are normal. He should be kept warm and prevented from making any muscular effort, because in his weakened state this may be fatal. Simple attention to the dangers that have been mentioned is bound to diminish accidents as a result of this new hazard of modern life.

CARBON DIOXIDE EXPLOSIVE

In some kinds of industrial blasting, shock of detonation is of distinct advantage; in others it has a decidedly adverse effect and should be avoided by all possible means. Shock produces a shattering effect on the material blasted. Consequently, dynamite or some other "quick" explosive is usually employed in quarrying rock or other mineral where it is desired to break it into small fragments. If large pieces are wanted, a "slow" explosive gives far better results.

In coal mining where the lump sizes usually bring a higher price than the slack or fine material, a comparatively slow, heaving action gives much better results than the quick, shattering, disruptive effort of high explosive. For this reason black gunpowder has been almost universally preferred in the past by miners and mine operators.

A new device on the American market, particularly applicable to coal production, is not an explosive and is not so classed by the United States Bureau of Mines, although it possesses some of the general characteristics of explosives. This device, known as Cardox, utilizes the expansive force of an inert and harmless gas for breaking down the coal at the working face. No smoke, flame, or noxious odors are produced, and the results obtained are unquestionably superior to those afforded by even the slowest of explosives.

The means employed to render an inert gas effective for this purpose are extremely simple. If we could make a miniature steam boiler—small enough so that it could be loaded into a bore hole like a charge of explosive—provide it with one weak plate that would rupture under a predetermined pressure without injury to the rest of the boiler shell; if we could fill this boiler with water; and if, after it had been placed within the coal to be shot down, we could quickly apply enough heat to evaporate the water, the pressure within the boiler shell would rise until the weak plate would give way. In other words, the "boiler" would "explode," and the surrounding coal would be broken and heaved down by the expansive force of the steam. This action on the coal would be far less disruptive than that of any ex-

plosive, just as the ordinary industrial boiler explosion is less destructive than that of a powder magazine.

Roughly speaking, the Cardox shell or cartridge is nothing more nor less than a small boiler provided with a weak plate and an instantaneous furnace. The "boiler" is a hollow, one-piece forging of high-grade alloy steel.

It is roughly bottle-shaped and provided with a filling valve at one end. The op-



CARBON DIOXIDE CARTRIDGE

posite end, or mouth, is closed by means of a soft steel disk—the weak plate in the boiler shell—which rests against a hardened steel shear ring. The joint gasket of fiber, disk, and shear ring are held securely in place by means of a steel cap that is screwed onto the shell neck.

The "instantaneous furnace" previously mentioned consists of a paper tube containing chemicals—sodium chlorate, charcoal, and powdered aluminum—capable of reacting with each other and producing intense heat. This heater also contains an ordinary electric match-head or squib, the wires from which terminate at either end. When in place within the shell, one end of this heater rests within and makes elec-

trical contact with a support that is insulated from the body of the shell, while the other end makes similar contact with the sealing disk, which is in electrical contact with the shell body.

Because of its low disintegration energy—latent heat of vaporization—as well as its inert nature and harmlessness while in the gaseous state, carbon dioxide is the material employed for charging the Carbox shell.

Today carbon dioxide is a fairly common article of commerce. Its use in soda fountains is familiar to everyone. It may be readily liquefied under pressure, provided its temperature is kept below the critical temperature, approximately 88.7 degrees, Fahrenheit. Above this critical temperature, it cannot be liquefied regardless of the pressure placed upon it. This is only a little above normal coal mine temperature, and, consequently, only a small amount of the heat evolved by the heater is taken up in raising the temperature of the liquid contents of the shell while the rest goes to superheat the gas formed when the critical temperature has been reached.

Depending upon its model, the shell is capable of holding from 3 to 4½ pounds of liquid carbon dioxide. The heater normally contains from 125 to 175 grams of heating compound, the exact weight varying with the thickness of the disk employed and the charge of carbon dioxide. These three elements—weight of charge, weight of heater, and thickness of disk—may be varied to suit the nature and texture of the coal to be brought down, and best results are secured when a proper balance between the three has been established.

In practice a shell is brought to the charging station where the heater and disk are renewed. The shell is then placed in a rack and liquid carbon dioxide pumped into it at a temperature of about 0 degree, Fahrenheit, and a pressure of approximately 900 pounds per square inch. When the desired charge has been loaded into the shell (as determined by weighing) the filling valve is closed, the shell removed from the rack, and the cap covering the valve end screwed lightly into place.

The shell may now be taken to the working face. An electric post drill readily drills a hole in the coal sufficiently large to receive the shell. As the shell is slipped,

discharge end foremost, into this hole, a terminal plug, with firing cable attached, is inserted in its outer end. Thenceforward the shell is treated exactly as if it were a charge of explosive. It is shoved to the back of the hole and tamped in place. The lead cables are connected to the firing cable; the operative retires to the nearest break-through, connects the firing cable to the terminals of a blasting machine, shouts a warning such as "fire!" or "fire in the hole!" to other workmen who may be in the vicinity, and, after a slight pause, gives the machine handle a vigorous twist.

The current from the blasting machine ignites the match-head which in turn starts the reaction between the chemicals of the heater. By this means in approximately 1/85 of a second as nearly as it can be measured, the liquid carbon dioxide within the shell is vaporized and the pressure jumps from the loading pressure of 900 pounds per square inch, to several thousand pounds per square inch, the exact pressure depending on the thickness and shearing strength of the disk. In any case this pressure exceeds the resistance of the disk and its central section first bulges and then shears against the hardened steel shear ring that supports it. This central portion or slug is caught and retained within the discharge cap while the gas that is liberated by the disk's failure escapes through the vent holes against the coal, which is broken and heaved down by the expansive force of the liberated gas.

Inasmuch as carbon dioxide is a colorless, odorless, tasteless, and inert gas, its presence in the atmosphere at a coal face is not perceptible to the senses except through its temperature. Thus the air in a place that has just been brought down by this means frequently is perceptibly cooler than before the "shots" were fired.

Since carbon dioxide is inert chemically, it can be breathed in small quantity without injury. The only ill effect of its presence in the air is its dilution of the normal oxygen content. Analyses of samples of the air at the working face taken as quickly as possible after a Carbox shot or series of shots had been fired have never shown more than 2.6 percent of carbon dioxide. The amount of dilution ordinarily encountered seldom exceeds .5 percent. Either of these percentages is negli-

gible so far as respiration and ill effects on the human body are concerned.

As has been stated, the release pressure of this gas varies with the thickness of the disk, ranging from 10,000 to 20,000 pounds as against the 50,000 to 55,000-pound explosion pressure of black powder and the 100,000 to 150,000-pound pressure for permissible explosive. The initial shock that is dealt the coal is thus far less with Cardox than with even the slowest of explosives and the shattering effect and amount of fine coal produced is proportionately less, so that more lump and less slack is produced. Not only this, but the shock and jar imposed on the roof strata is less violent and less timbering is needed.

Another and, in some cases the most

important advantage possessed by this means for bringing down coal, is its safety in the presence of explosive mixtures of air and fire damp, or methane. After test by the United States Bureau of Mines, Approval Number 1 was issued covering this cartridge as a permissible blasting device. It is thus not even classed as an explosive. Important as this safety feature may be, however, there are many coal mines in the United States and elsewhere in which methane is seldom, if ever found. To these, the improvement in quality of the product that its employment effects will be the important factor governing its adoption. To many mines this quality improvement is sufficient to spell all of the difference between an operating profit and a loss.—*Frank H. Kneeland.*

BLACK DIAMOND

HARDEST KNOWN SUBSTANCE

Hardest of all known substances is the diamond, and that property of the stone adapts it for many uses which while less romantic than its traditional role as a "solitaire," are indispensable to industry. Industrial diamonds, however, are not suitable for use as gems, being of two types—the black diamond, or carbonado, and bort, says Dr. Oliver Bowles in a report recently issued by the United States Bureau of Mines. The black diamond is the hardest known substance, the claim being made that it is 3 per cent harder than the gem diamond. It is lacking in cleavage, is opaque, and resembles a piece of lava or coal. Black diamonds are found chiefly and almost exclusively in the State of Bahia in the interior of Brazil. The second variety, or bort, consists of cull stones from the gem-diamond industry. Most of these are obtained from South Africa. Unlike the black diamond, bort has a distinct cleavage. Although the diamond is extremely hard it is also brittle and is easily shattered if subjected to a sudden shock or blow.

The chief use of industrial diamonds is in the manufacture of drill bits for rock

drilling and boring. The diamonds are set in the lower edge of a hollow cylinder of soft annealed steel. By rotation the bit cuts out a cylindrical core of rock. Black diamonds are used chiefly for this purpose. The chief use of bort is in the manufacture of tools for truing abrasive wheels and in the manufacture of cutting tools which are used for turning hard rubber, ebonite, vulcanite, fiber, metals and alloys, mica, and other materials that dull other tools quickly. Diamond tools are of special value for the production of a large number of pieces of exact and uniform sizes. Perforated diamonds are used as dies for drawing fine wire of accurate and uniform cross section. Diamond saws up to 10 feet in diameter are used widely for sawing rock such as marble and granite. The diamonds are mounted in detachable steel sockets inserted at regular intervals around the rim. Small diamonds are used extensively as glass cutters. Fragments of bort are pulverized to form diamond dust which is used for cutting and polishing precious stones, as an abrasive in drilling diamonds to make diamond dies, and in sawing porcelain and similar hard materials.

SCIENCE TRIUMPHS

From Byrd and Wilkins aloft in planes over Antarctica and Lindbergh over the Mayan jungles to such non-spectacular achievements as that of two young German chemists who split hitherto indivisible hydrogen, earth's simplest element, science made hundreds of advances in 1929, says the Associated Press.

Most of them are considered routine by scientists with the time still years away when their importance may be evaluated.

In evolution Dr. Austin H. Clark of Washington advanced data to show that new species can come into existence quickly, while at Carnegie Institution, St. Louis University, the University of California and many other places radium and X-ray emanations were shown to be an influence in producing changes in species.

Among very practical developments were finding of better mine gas protection by the United States Bureau of Mines, an improved egg preservation method at Cornell, a means of keeping fish fresh for a year in Canada, a non-explosive film made of cloth at Pittsburgh, a caterpillar tractor tow-boat on the Tennessee river, the Sperry rail-fissure detector traveling over the major American railways, and a telephone dial that speaks numbers.

HEALTH RESEARCHES

Health research provided many advances. At Yale, a method of treating pneumonia by carbon dioxide was announced. At Harvard, Michigan, Kentucky Agricultural experiment station and other places better or cheaper remedies for pernicious anemia were found.

Europe and America developed numerous advanced cancer treatments, without finding a remedy, and in the United States the pathologists of Rockefeller Institute reported evidence that they are a little closer to the extermination of tuberculosis in a cooperative research carried on by seventeen American scientific institutions.

Dr. Fisher in Germany made the red blood corpuscle synthetically for the first time. New methods were reported of extracting hormones useful for delaying the ravages of age in men and promising relief for some feminine ills.

SUNLIGHT PICTURE SCREEN

Study of light produced a sunlight picture screen in England and apparatus by Baird to materialize before the eye things hidden by darkness or behind fog. The use of ultra-violet rays spread so widely that medical authorities warned the public not to overdo.

The Eastman Kodak Company took motion pictures with the aid of invisible infra-red rays, the United States Bureau of Standards developed artificial daylight as "real" as that of a June day, and the General Electric Company produced light that changed its colors with fluctuations in the electrical current.

At the University of Iowa and numerous other places voice vibrations traced in light were used to train musicians. Similar translations of sound into light were experimented with for helping the deaf to see what they cannot hear.

Yale established an institute of human relations to tie in all branches of science with human affairs and Cornell launched an undertaking of the same order.

SMOKELESS TOBACCO

A few of 1929's developments to indicate the range of scientific exploration are smokeless tobacco, non-inflammable paper, gasoline made electrically at the University of Minnesota, gasoline made from fir trees, bromine made from sea water, a silver water filter, weighing of earthen dams at Massachusetts Institute of Technology, sound to make hearts beat and sound to reveal chemical composition of liquids.

The U. S. naval observatory has a new method of determining time. Einstein said that gravitation and electricity are related, a Canadian underwater listening device heard icebergs six miles distant and the Roosevelts brought a new bear from Asia.

Outstanding among the discoveries of the year were:

Ortho-hydrogen and para-hydrogen, two different kinds of hydrogen molecules having electrons revolving in different directions, discovered.

Pepsin, the enzyme which digests food, crystallized for the first time.

Influenza germ believed isolated.

A sugar substance generated by tuber-

culosis germs, which acts apparently as the agent of union between the tuberculosis bacillus and the human cell, discovered.

Rubber obtained from common U. S. plants.

Einstein's *Einheitliche Feldtheorie* given to Prussian Academy of Sciences for criticism.

Re-measurement of exact speed of light begun.

Diesel engines used successfully in long-distance airplane flight for the first time.

Aerial camera used by aviators for locating ruins and for taking long distance photographs.

Practical use of ship-to-shore telephone conversation.

Meteor in southwest Africa found to be biggest of its kind.

Sunrise over "Copernicus," a pit on the moon, effectively photographed.

200-in. quartz mirror telescope developed.

Manganese-molybdenum alloy developed for rails.

Ashton process developed for producing quantities of wrought iron at low cost.

The "Peking Men" (*Pithecanthropus Erectus*) found by a Canadian party near Peiping, China.—*The Scholastic*.

EVOLUTION

THE PRESENT DISCUSSION

Prof. Henry Fairfield Osborn's evolutionary theory, that man has developed independently from all simian connections since the Lower Oligocene age or even earlier, twenty to forty million years ago, meets with strong disagreement on several cardinal points from one of his own colleagues at the American Museum of Natural History, Dr. William K. Gregory. In an article which appears in the *American Journal of Physical Anthropology*, Dr. Gregory sets forth in full his reasons for differing with his chief. This is his twenty-eighth technical paper on this subject.

At the outset, Dr. Gregory sets forth a "list of fourteen points" wherein he and his distinguished friendly opponent are in essential agreement. These include the fundamental doctrine that man's ancestors in Eocene times were primates, or ape-like creatures; the survival of more conservative ancient types of anthropoids in the forests and the more rapid evolution of plains-living forms; the probability that some of the earlier crude stone "implements" were made by intelligent beings with large brains, and a number of other points.

With regard to the human brain, however, Dr. Gregory disagrees with Prof. Osborn's belief that no geologic time thus far assigned is sufficiently long enough for

its evolution. He points out that students of anatomy have found that the brain of the gorilla, while having less elaborate convolutions, exhibits nearly all the basic pathways and interconnections of the human brain, except for the speech centers. He is therefore of the opinion that the fifteen million years tentatively assigned by geologists as the time that has elapsed since the human stock began to develop in a definitely human direction, has been enough for the human brain to grow up in.

Prof. Osborn lays considerable stress on tree life as unfitting the hands of animals that adopt it for later evolution into hands of the human type. To meet this, Dr. Gregory cites the resemblances between the hands of human beings and those of adult gorillas and chimpanzees, which are admittedly arboreal and yet retain many fundamental resemblances to the human hand. He also states that Sir Arthur Keith and Dr. Dudley Morton agree with him in holding that brachiation, or the grasping of branches while clambering around in trees, was a necessary factor in turning man's backbone upright.

In all, Dr. Gregory lists ten major points of disagreement between himself and Prof. Osborn.

THE INSIDE OF A TORNADO

The thrilling tale of a man who saw the inside of a tornado and lived, unhurt, to tell of his experiences is contained in a report made to Alonzo A. Justice, of the Weather Bureau office here, by Will Keller, a farmer near Greensburg, Kansas. Though it happened two years ago, Mr. Justice considers the account of such importance that he has reported it to the Weather Bureau headquarters in Washington.

Mr. Keller explained that on the afternoon of June 22, 1928, he noticed the approach of a dark cloud and saw that it consisted of not only one tornado, but three. After hurrying his family to the cyclone cellar, he paused to watch the approach of one of the funnel shaped clouds, which was coming directly towards him.

"I have seen a number of these things and have never become panic stricken when near them. So I did not lose my head now, though the approaching tornado was indeed an impressive sight," he explained.

"The surrounding country is level and there was nothing to obstruct the view. There was little or no rain falling from the cloud. Two of the tornadoes were some distance away and looked to me like great ropes dangling from the clouds, but the near one was shaped more like a funnel with ragged clouds surrounding it. It appeared to be much larger and more energetic than the others and it occupied the central position of the cloud, the great cumulus dome being directly over it.

"As I paused to look I saw that the lower end which had been sweeping the ground was beginning to rise. I knew what that meant, so I kept my position. I knew that I was comparatively safe and I knew that if the tornado again dipped I could drop down and close the door before any harm could be done.

"Steadily the tornado came on, the end gradually rising above the ground. I could have stood there only a few seconds but so impressed was I with what was going on that it seemed a long time. At last the great shaggy end of the funnel hung directly overhead. Everything was as still as death. There was a strong gassy odor

and it seemed that I could not breathe. There was a screaming, hissing sound coming directly from the end of the funnel. I looked up and to my astonishment I saw right up into the heart of the tornado. There was a circular opening in the center of the funnel, about 50 or 100 feet in diameter, and extending straight upward for a distance of at least one half mile, as best I could judge under the circumstances. The walls of this opening were of rotating clouds and the whole was made brilliantly visible by constant flashes of lightning which zigzagged from side to side. Had it not been for the lightning I could not have seen the opening, not any distance up into it anyway.

"Around the lower rim of the great vortex small tornadoes were constantly forming and breaking away. These looked like tails as they writhed their way around the end of the funnel. It was these that made the hissing noise.

"I noticed that the direction of rotation of the great whirl was anti-clockwise, but the small twisters rotated both ways—some one way and some another.

"The opening was entirely hollow except for something which I could not exactly make out, but suppose that it was a detached wind cloud. This thing was in the center and was moving up and down.

"The tornado was not traveling at a great speed. I had plenty of time to get a good view of the whole thing, inside and out. It came from the direction of Greensburg, which town is 3 miles west and 1 mile north of my place. Its course was not in a straight line, but it zigzagged across the country, in a general north-easterly direction.

"After it passed my place it again dipped and struck and demolished the house and barn of a farmer by the name of Evans. The Evans family, like ourselves, had been out looking over their hauled-out wheat and saw the tornado coming. Not having time to reach their cellar they took refuge under a small bluff that faced to the leeward of the approaching tornado. They lay down flat on the ground and caught hold of some plum bushes which fortunately grew within

their reach. As it was, they felt themselves lifted from the ground. Mr. Evans said that he could see the wreckage of his house, among it being the cook stove, going round and round over his head. The eldest child, a girl of 17, being the most exposed, had her clothing completely torn off. But none of the family were hurt."

Mr. Justice endorsed Mr. Keller's story with the following words:

"Mr. Keller's reputation for truthfulness and sobriety is of the best. Apparently he is entirely capable of making careful and reliable observations." — *Monthly Weather Review*, U. S. Dept. of Agriculture.

ROSETTA STONE

One of the most important discoveries of the eighteenth century, from an historical point of view, is the key to Egyptian hieroglyphics, known as the "Rosetta Stone," now in the British Museum. For fourteen hundred years the hieroglyph was a dead language, and the history of Egypt, except that contained in Genesis, was a sealed book. In August of 1799 the key was accidentally found. It was discovered by the French Exploration Company, under Napoleon, while making an excavation for a fort at Rosetta, in lower Egypt, and hence is called the Rosetta Stone. This stele (an engraved stone) contains an inscription written in three different languages—Hieroglyphic, Demotic, or the more common language of the Egyptians, and Greek. From the Greek text it was discovered that the inscription was trilingual, and that each of the writings was a translation of the other. Beginning with this clue, Dr. Young, in 1815, finally succeeded in deciphering from the hieroglyphical character the single word Ptolemy; and, to the profound amazement of the scholars of the age, the spelling was found to be phonetic (by sound), and not ideographic (by object or idea). This learned antiquarian also made out the name Berenice, among pictorial writings in the frescoes of Karnak. In 1822 Champollion deciphered the word Cleopatra from an obelisk found at Philae. Afterwards continuing his researches, he was able to complete the translation of the Rosetta Stone, thereby opening up the whole field of Egyptian history. It is now known that in the course of Egyptian annals, down to the time of the Roman Emperors, four systems of writing were successively employed; further back than the oldest of these, it is evident that pictorial symbols were used to represent ideas, but at what date the ideograph (or picture-writing proper) flourished, and

under what circumstances it gave place to an improved style of conveying thought, cannot be known. The oldest system of writing in the world is this so-called hieroglyphic, or sacred carving. The investigations of those in Egypt, since 1822, have resulted in strong proof of the authenticity of the Old Testament Scriptures.

The Rosetta Stone is of black basalt, about three feet seven inches in length, two feet six inches in width, and ten inches thick. It was dug up by a French officer, named Bouchart, and was expected to augment the treasures of science in the Louvre; but the victory of Lord Hutchinson, and the consequent capitulation of Alexandria, transferred it to the hands of the British, and it was landed in Portsmouth in February, 1802. The stone is handsomely mounted, and is one of the highly prized treasures of the British Museum. The inscription is a decree, in honor of Ptolemy Epiphanes, by the priests of Egypt assembled in a synod at Memphis, on account of the remission of arrears of taxes and dues owed by the sacerdotal body. It was set up in 195 B. C., and is the only one of the number ordered to be erected which has as yet come to light. Since its discovery, other tablets, of greater variety, far more important and more nearly perfect, have been discovered, but this is the only one with a corresponding Greek inscription. Now, by means of the Rosetta Stone, hieroglyphics can be translated as readily as any of the classic writings. The length of the inscription does not admit of more than a brief extract here. It begins, "In the reign of the youthful king who received the kingdom from his father," and closes, "Write this decree upon a column of hard stone, in sacred, and enchorial and Greek letters, place it in each of the temples of the first, second and third orders, near the image of the ever living King."

RESEARCH LABORATORIES

The United States now has 1,000 research laboratories enlisting about 33,000 workers and expending annually, so far as can be determined, about \$210,000,000, Dr. H. W. Gillett, Director of Battelle Memorial Institute, Columbus, Ohio, says in "Industrial and Engineering Chemistry."

These figures do not include college, university, and Government laboratories, or control and testing laboratories. Statistics in regard to the amount expended in the research activities of the nation are pretty much guesswork, Dr. Gillett points out.

The dividing lines between research in pure science, industrial research, development work, plant "trouble-shooting," attention to customer complaints, and routine analysis and inspection are so hazy that, without a census in which all items of so-called research are clearly classified, one is at sea in guessing the extent of research, he declares.

It is estimated that the United States spends \$10,000,000 and has 3,000 workers in pure science and \$200,000,000 with 30,000 workers in applied science.

Since the Bell Telephone Laboratories alone have a yearly appropriation of some \$19,000,000 for research and development, and employ 6,000 people, the above estimate is probably of the right order of magnitude.

No one can state exactly what is expended for research by or for any one industry, but chemistry and metallurgy are probably in the lead since, on a basis of capital invested, chemical and allied industries spend 2.4 per cent and the metal-working industries 2.1 per cent for this purpose.

Extensive metallurgical research is in progress in the leading nations. In America, the Federal Government, the universities, scientific and engineering societies, and trade organizations are fostering this branch of scientific investigation.

Private metallurgical research in the United States is distinctly on the up-grade, Dr. Gillett reports. New metallurgical research laboratories for private firms have recently been installed by the U. S. Steel Corporation, the Crane Company,

Follansbee Brothers, Handy and Harman, and a long list of others.

The Aluminum Company of America is finishing a fine new laboratory. The latest coalition in the steel industry announces the formation of the Republic Research Corporation. Metallurgical research is included in the program of the newly-formed Swann Development Corporation.

Major problems of research in metallurgy, which is a branch of chemistry, include the constant battle for the defeat of corrosion, and the search for alloys to resist stress and oxidation at high temperatures. The chemical industries, the oil industry, and the power-plant industry are pressing the metallurgist for still further advances in alloys to resist corrosion and high temperatures.

Take, too, the projects on the direct reduction of iron ores and on the production of clean steel. The official title of the last project is "the physical chemistry of steel making." All these are quite distinctly chemical.

Metallurgy is a key industry. Of the ten leading industries from the point of value of manufactures, eight are metal-working and metal-using industries.

Even those industries which do not directly make metallic products are highly dependent on them. The food industry needs agricultural implements and tin cans; the lumber industry, saws; the chemical industry, tanks and piping; and so on down the line.

Transportation—by railway, steamboat, automobile, and aircraft—is today in vehicles that average some 90 per cent or more metallic. Water, gas, electricity, and telephone and telegraph messages are transported by metallic pipes or wires; even the radio waves depart from, and are collected by, metallic apparatus.

A normal household uses alloys of at least twenty different metals. One finds them from the bathroom to the kitchen, on his person, in his mouth, and in his automobile. In his daily work and his daily life everyone is served by metals, and is benefited by the search for better and cheaper alloys.

SINANTHROPUS, THE PEKING MAN

THE MILLION-YEAR-OLD FOSSIL

Anthropologists are attaching vast significance to the fossil finds that have been reported from time to time from the vicinity of Peking, or Peiping. As the possible significance of these fossils gradually emerges, men of science are filled with eagerness to see the excavations completed; likewise to know the full evolutionary meaning of the finds already made. It is manifestly impossible to make more than a preliminary determination short of painstaking, detailed study at present. No discovery of fossil man since that of *Eoanthropus*, the "Dawn Man" of Piltdown, England, has aroused interest to such a fever pitch among anthropologists.

Owing to the accident of geographical location the belief appears to have become widespread that the fossils of *Sinanthropus* were those of an ancestral Chinese. No such assumption is justified by the facts, for the antiquity of *Sinanthropus* is doubtless a million years. The existence, even 10,000 years ago, of a race in a part of the world which the original owner of the bones in question inhabited 100 times as far back in the remote past is doubtless little if any more than a coincidence.

Science has but small knowledge of the origin of the human races, with regard to time, place, cause, or manner. In 1,000,000 years, or even 100,000 years, a race would have ample time to have passed through many vicissitudes, wandering far afield from its point of origin. Therefore the search for the "cradle of the human species" is likely to prove elusive. The human species evolved from some earlier animal, and this process doubtless took place gradually, covering a vast period of time. When, then, and where in its possible wanderings, can the human species be said to have been cradled? Had we a perfect rather than a fragmentary collection of ancestral fossils the impossibility of attempting to choose the "beginning" of humanness in what would then be seen to be a long, gradual transition doubtless would become more patent.

From our contemporary, the *Illustrated London News*, we reproduce the accom-

panying illustrations and quote the following comment on the Peking Man (by the way, the single skull found has turned out to be that of a woman), written by Professor G. Elliot Smith, Professor of Anatomy in the University of London, author of "The Evolution of Man" and other books, also of several articles previously published in the *SCIENTIFIC AMERICAN*, and one of a dozen leading authorities on human evolution. Professor Davidson Black, to whom Dr. Elliot Smith refers in his opening paragraph, is a Canadian anatomist attached to the Peking Union Medical College, and has had more to do with the discoveries of *Sinanthropus* than any other man of science.

"The discovery of the first complete brain-case of one of the three earliest and most primitive members of the human family is obviously an event of exceptional interest and importance. Most people are skeptical of reconstructions of ancient skulls built up from fragments. Hence the finding of a specimen which is intact provides a more convincing demonstration. Professor Davidson Black's courtesy in permitting the reproduction of the photograph, which reveals part of the wonderful fossil, makes it possible for us to appreciate something of the significance of what is probably the most illuminating discovery of early human remains ever made.

"Until November, 1928, nothing was known of the existence of the early Pleistocene Man in China, beyond some teeth, on the basis of which Professor Davidson Black, with great daring, created the new genus and species of the human family, *Sinanthropus pekinensis*, to which he assigned approximately the same antiquity as the famous apeman of Java, *Pithecanthropus* found by Dr. Eugene Dubois in 1891. On the last day of the excavations in 1928, however, Dr. Black's boldness was completely justified by the discovery of fragments of two jaws, those of an adult and a child, in association with the fragments of two brain-cases of corresponding ages.

"History repeated itself last winter: again on the closing day of the season's excavations (Dec. 2, 1929), the young Chinese paleontologist, Mr. W. C. Pei, of the staff of the Geological Survey of China, while excavating the sheltered recess of the main deposit at Chou Kou Tien, discovered the greater part of an uncrushed adult skull of *Sinanthropus pekinensis*. Mr. Pei at once recognized the importance of the specimen, and personally carried out the difficult work of excavation and preparation of the block of

collected in a preliminary report on the geology and paleontology of the site by Père Teilhard de Chardin and Dr. C. C. Yong definitely establishes this fact. Though hundreds of cubic meters of material have been examined, no implements or artifacts of any kind have been found, nor has any trace of the use of fire been observed.

"The photograph of this skull enables us to get a much more exact idea of the nature and affinities of this early inhabitant of eastern Asia than earlier descrip-



SINANTHROPUS PEKINENSIS

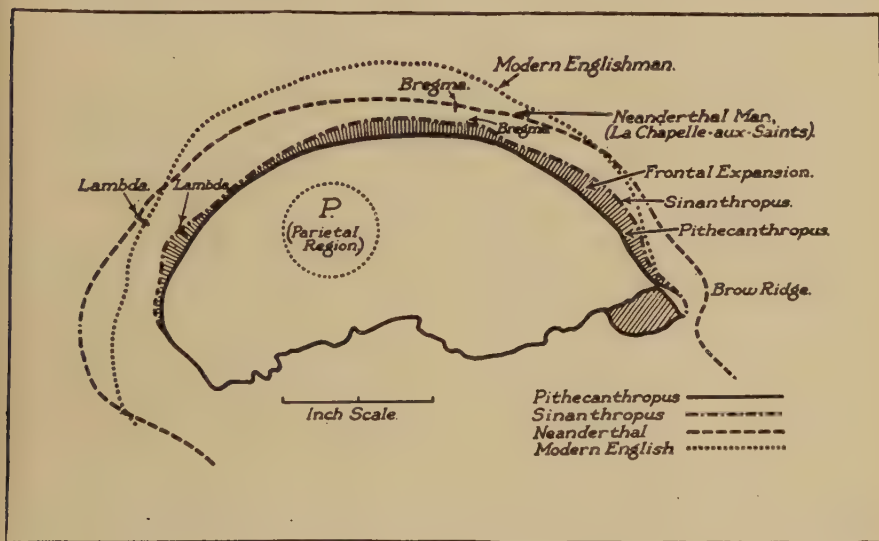
matrix in which it lay. It is entirely due to his skill and devotion that this bulky mass, with its unique and fragile contents, reached the Peking Laboratory quite undamaged.

"Contrary to the reports which have been circulated, no skeletal parts other than the skull and numerous isolated teeth have been recovered during this year's excavations. The different sites where *Sinanthropus* has been discovered in the Chou Kou Tien deposit are all clearly contemporaneous with one another, being Lower Quaternary in age. The evidence

tions conveyed, and we are able to correct misunderstandings arising out of the telegraphed reports. The greater part of the left side and the forepart of the base of this unique skull is still embedded in a block of very hard travertine. The vault, from its massive brow-ridges in front to the back of the skull, and the whole right side seen in the photograph, were embedded in a relatively soft matrix, which has now been removed. The brain-case has been almost completely preserved, while most of the facial region would seem to be lacking.

"The skull of *Sinanthropus* is of approximately the same length as that of *Pithecanthropus*, and, like the latter, is provided with massive brow-ridges. However, *Sinanthropus* differs from the Java apeman in the following important features: there is a slight filling out of the forehead; expansion of the localized parietal eminences on the sides of the head above the ears; and a greater height of the vault. All these differences point to a relatively greater brain capacity in *Sinanthropus*. The mastoid processes (not seen

seen from the right side, has been superimposed (in adjoining diagram) on similar projections of the cranial fragment of *Pithecanthropus*, the La Chapelle skull (Neandertal species), and a random sample of a modern Englishman's skull. Neandertal man and *Pithecanthropus* have been chosen for comparison because the new skull presents a much closer analogy to these two types than it does to the Piltown man. There is a similar flattening of the skull, and all three have very pronounced eyebrow ridges. It will be seen,



THREE FAMOUS FOSSILS COMPARED

in the photograph) are small and rugged. The sockets in which the lower jaw articulated are well preserved on both sides, a circumstance which will be of great value in the restoration of the lower jaw from the fossils recovered in 1928. While the new specimen bears out what little was already known from the fragments found in the previous year, the perfection of its preservation will enable much to be learned that is now obscure concerning the evolution of the head in early man.

"To show the distinctive characters of this newly found specimen, its outline, as

however, that in the frontal region there is a distinct fullness of the skull of *Sinanthropus* in comparison with that of *Pithecanthropus* in the region marked 'frontal' in the drawing; and that the skull is slightly loftier. According to the report (quoted from Professor Davidson Black), there is a greater fullness in the parietal region marked 'P' in the diagram, which is one of the significant areas in which the human brain differs from that of the apes, and modern man from primitive man.

"The skull is, therefore, one of particular interest."

UR IN ANCIENT CHALDEA

The explorations which have been conducted for several years in Mesopotamia by a joint archaeological expedition of the University of Pennsylvania and the British Museum, under the direction of C. Leonard Woolley, have been particularly prolific in important discoveries during the past year. The principal part of the exploration work done consisted of extensive excavations on the site of the ancient Sumerian city of Ur, which had been built more than 4,000 years ago.

One of the most interesting discoveries were the remains of the wall which had surrounded the city of Ur for many centuries before the birth of Christ. According to the report of Mr. Woolley the wall has already been traced for a length of two and one-half miles and the excavation work will be continued. Because of the fact that it was built of highly perishable material, little is left, but enough to enable us to imagine its imposing grandeur about 4,000 years ago.

In the report it is stated that the wall was built by King Ur-Engur about 2,300 B.C. The base of the wall was a rampart of mud-brick, while the wall itself, which rested on it, was of burnt brick. The rampart was about twenty-six feet high, while its width varied between seventy and more than ninety feet. The back of the rampart was almost hidden by the terrace on which the town stood and for which it acted as a retaining wall. Its front sloped sharply downward and for a considerable distance was washed by the waters of a wide canal. As a matter of fact, in 2,500 B.C. the city of Ur was almost completely surrounded by water. The Euphrates ran west of the city, canals along its eastern and northern borders and another canal

ran through the middle of the city, close to the limits of the Sacred Area.

At the northern end of this central canal was a large harbor enclosed by long walled moles thrown out from the main line of the defenses, while on the southwest a second, but smaller harbor lay inside the town wall.

So far, the excavations have brought to light four temples, of which the two oldest, dedicated to En-Ki, the water god, and to Ningishzida, the brother of Adonis or Tammuz, dated from 1990 and 1985 B.C. The other two had been built by Rim-Sin of Larsa, a contemporary of Abraham. Under one of the Rim-Sin temples ruins of a considerably earlier period were found, which included among their interesting features several well preserved brick columns dating from the third Sumerian dynasty.

Other surprising finds were made in Ur, which clearly prove, that the Sumerian architects four thousand years ago were already familiar with such basic principles of architecture as the arch, the apse, the column and the dome and used their knowledge of optical illusions to produce architectural effects, a method which the Greeks considerably later employed in the construction of the Parthenon.

The ancient Sumerians were undoubtedly skillful workmen, because brick walls, which they had built four thousand years ago, are still in as good condition as walls constructed by present-day workmen in near-by towns. The explorations will be carefully and diligently continued and the thorough study of the discovered facts will undoubtedly vastly increase our heretofore sadly limited knowledge of the ancient Sumerians and their remarkably high state of civilization.

BLUFF-DWELLER INDIANS

RAISED VARIED CROPS THOUSAND YEARS AGO

The Ozark Bluff-Dwellers were a culture group in the Ozark Mountains a thousand years ago or more, probably more. They were followed by a second culture group, this group also being prehistoric. After that came the historic Indians.

The Ozark Bluff-Dwellers did not know the bow and arrow; they had as a propulsive weapon the dart-thrower or atlatl. But they practised agriculture, and cultivated several varieties of corn and of beans, and also several varieties of pumpkins (including what we call summer squashes), as well as winter squashes of the well-known Hubbard type. They also cultivated egg gourds. Among their varieties and types of corn they had dent corn in every way similar to the well-known twelve-row, red cob, yellow dent corn grown today throughout the corn belt states. They cultivated sunflowers for their seed for food purposes, and their sunflowers were as large, and the seeds were as large as those of the cultivated sunflowers we know today.

In the vegetal remains left by these ancient people there is abundant evidence of the uses of many species of the native plants of the region for various purposes, for food, for manufactures, for medicines, for fibers, and so forth. They seem to have cultivated certain species of plants besides the staple crops of corn, beans, squashes, pumpkins and sunflowers, species which later people allowed to lapse from cultivation. The evidence of the cultivation of these other species of plants which

in later times have not been cultivated lies in the fact that supplies of the seed of these species were carefully put away by the Bluff-Dweller people among their selected seed stock of corn, beans, sunflowers, squashes and pumpkins. Among these other species of plants which appear to have been cultivated by those ancient farmers of the Ozarks, were a species of lamb's quarters, a pigweed species, and Carolina canary grass.

In view of the fact that ever since the European discovery of America we have been accustomed to think of the cultivation and use of tobacco by Indians generally, it is remarkable that it appears the Ozark Bluff-Dwellers did not have it. I have not found a single trace of any part of a tobacco plant, neither seeds, stems nor leaves. In this connection it should also be said that not a pipe was found among all the artifacts of the Bluff-Dwellers. So it would seem that at the time of occupation of the Ozarks by this prehistoric people the tobacco complex had not yet extended so far to the north and east from its center of origin.

By the absence of tobacco from among the vegetal remains of the Ozark Bluff-Dwellers, and also from observation of some traits in connection with the cultivation, harvesting and preparation of this crop among many different tribes of historic time, I conclude that the tobacco complex was in its origin no part of the agricultural complex of corn-bean-squash culture.—*Dr. Melvin R. Gilmore in Science Service.*

ROSICRUCIANS

In the years 1614, 1615, and 1616, there were published at Cassel, Germany, three books with long Latin names, which created a great sensation. These books contained the most wonderful stories about a certain secret society, the Rosicrucians, founded in the fourteenth century, possessed of the deepest wisdom, and working most potently for the good of mankind. The third book contained stirring revelations concerning the founder of the society, Christian Rosenkreutz, his residence among Arab and Egyptian magicians, his life in Spain and Germany as head of the order, his death and burial. The greatest excitement prevailed, some people were eager to join this new order, others were ready to fight against it. Some theologians believed it a means to salvation, others, the organ of a scheme to overthrow Christianity. Some physi-

cians believed that the "elixir of life" had been found; while alchemists were sure that the society had found the "philosopher's stone," and that gold could now be manufactured. For several years the secret society of the Rosicrucians was the all-absorbing topic of the day; yet no one ever owned himself to be a member, and even the real existence of such a society was not demonstrated. The whole affair was a mystification, and for what purpose, and by whom, the books were written, remains a mystery.

There arose numerous Rosicrucian societies, and as late as the end of the eighteenth century, Cagliostro pretended to be a Rosicrucian. By some, Johann Valentin Andrea has been named as the author of the books, which they considered simply as a satire. Others held different opinions, and various explanations were offered.

STONE AGE WEAPONS

MADE BY MODERN HUNTER

The "lost art" of manufacturing flint arrow points and granite hammers like those used by ancient and primitive men, has been successfully revived by a modern hunter, according to a report from Beloit Museum, by Alonzo W. Pond, archaeologist.

For years, the report states, Halvor Skavlem has studied the evidence afforded by the good and rejected stone weapons lying about the Indian village site at his summer home on Lake Koshkonong. Seventeen years ago he first attempted to shape a bit of flint into an arrow point, using a pointed bone for a tool as he imagined an Indian hunter would have done.

A good many archaeologists and amateurs have made such experiments as this first one, the report points out, but Mr. Skavlem has "revived the art for he has made thousands of arrowheads and scores of axes in the past seventeen years, using only the tools available to primitive man. He has done this quickly in the presence of thousands of witnesses with the skill of a true artist who knows the

limitations of his medium and who is master of his technique."

Some other experimenters have said they can demonstrate how flakes are removed in the shaping of stone tools and weapons, the report continues, but they admit that they cannot explain it to others. The Wisconsin arrow-maker has analyzed the primitive techniques and has explained the types of blows and angles of fracture which the Indians used to produce their arrows, hammers, spear heads, and axes.

An ordinary stone arrow point can be shaped in two to five minutes, by this modern master of stone-age craft. Within half an hour he can produce the groove of a stone axe. This is cited by Mr. Pond as good evidence that stone-age weapon making proceeded with reasonable speed and efficiency, and was not the long, tedious, and difficult labor which it has sometimes been described.

Mr. Skavlem, who is now eighty-four years old, is continuing his experiments with the primitive stone worker's art.—*Science Service.*

GREATEST ENGINEERS

The greatest engineer of all time is James Watt, improver of the steam engine, the deans of American engineering schools have decided.

A list of the greatest engineers, both of all time and of the last 25 years, was made public for the first time when the students of the School of Technology, Villanova College, met to make plans for the celebration of the 25th anniversary of the Villanova engineering department. The celebration was held in June.

Dean Cart T. Humphrey of the Villanova School of Technology invited every dean of engineering in America to name the greatest engineers. Their selections appear in two groups.

The five outstanding engineers of all time:

James Watt.

Leonardo da Vinci, planned and constructed the Martesana Canal.

Thomas A. Edison.

James B. Eads, boat and bridge engineer.

Ferdinand de Lesseps, French engineer who built the Suez Canal and projected the Panama Canal.

The Villanova survey shows that the 10 greatest engineers of the last 25 years are:

Herbert Hoover, for his work in mining and administration.

Charles P. Steinmetz, electrical genius.
Thomas A. Edison.

John F. Stevens, for his work on the Panama Canal, and as head of the American Railway Mission to Russia, 1917-18.

John Hays Hammond, mining.

George W. Goethals, engineer-in-chief of the Panama Canal.

George W. Westinghouse, airbrake inventor and pioneer in introducing alternating current machinery.

Guglielmo Marconi, inventor of wireless telegraphy and responsible for first broadcasting in England.

Henry Ford.

Ralph Modjeski, engineer of the Delaware River Bridge at Philadelphia and the Ambassador Bridge which connects Michigan and Ontario, Canada.

Editor's Note: It is rather surprising to see the name of Henry Ford, the great industrialist, in a list of great engineers and not find such names as Sprague, Sperry, Berliner, Fessenden, Brush, Pupin, deForest, Maxim, etc.

SKYSCRAPERS

(See also Vol. V, page 87)

Each year finds new buildings completed and new ones announced. Already the list we gave last year shows quite material differences between the project and the finished product. So we give here the dimensions of the ten tallest structures in New York City compared to the Eiffel

Tower, together with the names of the architects who designed them, as accurately as they can be determined. Incidentally it is interesting to note that the Singer Building erected 23 years ago, is still fifth in the list of tallest buildings in New York City.

	Date	Observatory Platform (ft.)	No. of Floors	Top of Flagpole (ft.)
Eiffel Tower (Gustave Eiffel).....	1888	906	—	1024.5
Manhattan Co. Building (N. Craig Severence, Inc.)	1930	836.4	70	927
Chrysler Building (William Van Alen).....	1930	783	73	1046
Woolworth Building (Cass Gilbert).....	1912	727	55	792.4
Lincoln Building (J. E. R. Carpenter).....	1930	653.5	53	673.5
Singer Building (Ernest Flagg).....	1907	612	45	674
Metropolitan Life Ins. (N. Le Brun).....	1908	590	46	657
Chanin Tower (Sloan & Robertson).....	1929	588.6	54	623.6
10 East 40th St. (Ludlow & Peabody).....	1929	588.3	48	632.3
N. Y. Life Ins. (Cass Gilbert).....	1929	612	45	674

RAILWAY OPERATIONS IN 1929

Every year supplies its own story of railway performance. Traffic may go up or down. Efficiency may continue to improve. The financial results may be encouraging or not. To weave these factors into a composite picture is no easy task, but the picture, if accurately sketched, presents a profile of commerce and industry as a whole. For the railways, as we must remind ourselves from time to time, serve all industries and all sections. Their traffic rises and falls with the curve of commercial activity, and they prosper in sympathy with the nation's prosperity.

Analysis of railway results in 1929 will, therefore, bring out some of the significant economic trends of that year, and will throw light on the effect of the financial upheaval that occurred during the autumn months.

Railway freight traffic in 1928 lagged behind the preceding year until July, then turned upward for the balance of the year, bringing the year's aggregate to a point higher than in 1927, and only slightly below the record-breaking totals of 1926. The momentum so gained at the end of 1928 carried over into 1929, and every month to September showed an increase over 1928. Again there was a turning point, this time downward, which first appeared in October and continued through the balance of the year. The net result of a traffic increase for nine months of 1929, and a decrease for the last three months, was an increase over 1928 as a whole, amounting to more than two per cent in terms of carloadings, and more than three per cent in terms of ton-miles. Compared with 1926, the previous record year of freight traffic, carloadings showed a slight decrease, and ton-miles a slight increase.

Passenger traffic continued its decline, but at a lower rate than in 1928.

Financial results closely followed the traffic factors. Freight revenue increased and passenger revenue fell off. With the assistance of increases in all revenue groups, except from passenger service, and with the further assistance of back mail pay receipts during the year, total operating revenues reported an increase. Operating expenses and taxes also increased, but the net operating income

maintained a position nearly seven per cent above 1928. This net operating income increased consistently during the first eight months of 1929, and as consistently declined during the remaining four months.

Rate of return on property investment averaged 4.95 per cent in 1929, compared with 4.72 per cent in 1928.

Striking progress was made in operating efficiency. Nearly all the factors of performance registered some gain, so that the whole standard of operation moved upward to a higher level than ever before. The results for 1929 again marked a forward step in the railway program for greater operating efficiency, which year by year since 1923 has been making its growing contribution to the economic progress and stability of the United States. This fact is coming to be realized by business men, economists, and others, and official recognition of it may be found in many quarters.

The latest annual report of the Secretary of Commerce, for example, contains the following succinct appraisal of the economic value of railway efficiency:

The quality of service furnished by the railways, as well as by other public carriers, is better now than at any other time in the history of the country. Shortages of cars have now become rare occurrences. At present it takes scarcely two-thirds as long to move goods a given distance as it did a decade ago. With the increasing efficiency with which traffic is being handled, producers are able to make quicker deliveries and distributors are able to carry smaller stocks and to turn over their capital more quickly. As a result goods are cheapened to consumers.

In his annual report to Congress, the President of the United States last December expressed the same thought in somewhat different language, as follows:

As a whole, the railroads never were in such good physical and financial condition, and the country has never been so well served by them. The greatest volume of freight traffic ever tendered is being carried at a speed never before attained and with satisfaction to the shippers. Efficiencies and new methods have resulted in reduction in the cost of providing freight

transportation, and freight rates show a continuous descending line from the level enforced by the World War.

Toward the close of the year, the nation received another striking indication of the extent to which the railway industry contributes to the common welfare, not only through its transportation service, but also through many collateral channels. The railways supply employment to many other industries through their purchases of material and supplies, and through their programs of capital improvement. They distribute large sums in these and other ways.

When stock market prices broke sharply in late October and succeeding weeks, and it became necessary to re-establish confidence, leaders turned to the railway industry at once for help. Railway representatives were first to be called to the White House for conference, and when a nation-wide plan for the general conference at Washington on December 5 was formulated, the railway spokesman was again placed first on the program. He was able to assure the country that the railways would continue to buy supplies, would increase their capital program for 1930, and would contribute loyally to continued industrial activity.

GENERAL SUMMARY.

A summary of the principal factors of railway operation in 1929 reveals the following significant features:

1. Net ton-miles for the year, 492,180,000, were 3.1 per cent greater than in 1928. This freight traffic factor was greater than in any previous year, surpassing the previous record attained in 1926.

2. Revenue freight carloadings, 52,790,000 cars, were greater by 2.3 per cent than in 1928, and stood at a higher level than in any previous year except 1926.

3. Passenger miles, 31,078,000,000, declined in ten of the twelve months of 1929, the decrease for 1929 as a whole being 1.7 per cent.

4. Total operating revenues, \$6,352,000,000, increased 2.6 per cent over 1928. Railway revenues in 1929 fell slightly below 1923 and 1926, but were greater than in any other preceding year.

5. Total operating expenses, \$4,554,000,000, were higher than in 1928 by 1.6 per cent, but fell below those of any preceding year back to 1922. Maintenance expenses, \$2,074,000,000, in 1929 showed slight increases, but the cost of conducting transportation remained almost stationary, despite the increase in freight traffic.

6. The operating ratio really tells the story of economy of operation. This ratio stood at 71.7 per cent in 1929, which was lower than in any year since 1917. The railways continued to exert that strict control over their expenses which has featured their operations for several years past.

7. Net railway operating income aggregated \$1,275,000,000, an increase of \$81,000,000 over 1928.

8. The rate of return on property investment in 1929 was 4.95 per cent. This was higher than the 4.72 per cent of 1928, but less than the rate earned in 1926.

9. Maximum levels of performance were reached in at least twelve factors of efficient operation, while the railways maintained satisfactory levels in the majority of the remaining factors.

10. The index of general railway efficiency in 1929 was higher than in any year since the war, being nearly three per cent above 1928, and more than 25 per cent above 1922.—*Bureau of Railway Economics, Miscel. Series No. 51.*

THE GYROSCOPE

In seeking the beginning of the history of the gyroscope, we must go far beyond the time when the word gyroscope was first used and consider the history of free spinning bodies. A rotating body, if its axis is not rigidly fixed but is free to turn in any direction, exhibits certain properties which have always been considered unusual and even mystifying. The spinning top was the first application of a rotating mass with a free axis. The origin of this toy is lost in antiquity and many different types of tops have been used by various peoples. The fascination of this toy lies in its persistency in defying gravity by standing up on its point when spinning. Tops have come down through the centuries without ever losing any of their popularity and even now they are one of the favorite toys of children in the endless variety of forms in which they can now be obtained. Unfortunately, the gyroscopic phenomena exhibited by spinning tops are not simple, but are a complicated combination of several simple elements, which we will discuss separately.

Another toy which utilizes the rotation of a mass with free axis is the peculiar device called the diablo. The diablo is a symmetrical mass consisting of either two cylinders or two cones connected together by a small neck and spun by manipulating a string under this neck. The origin of this peculiar device is Chinese. It seems that the fishmongers of China first used this principle as a method of announcing their approach through the narrow Chinese streets. Their diabolos consisted of two rather large cylinders joined together with holes in the periphery which caused the cylinders to sing with a weird hum and this singing diablo was the cry of the fishmonger, just as in this country the peanut vender has adopted his shrill whistle.

The diablo was brought from China to England and France by missionaries as long ago as the Seventeenth Century, and during the gala days of the French Court, when their most arduous task was to amuse themselves, the diablo became a veritable rage and all the lords and the ladies played with this unusual toy. The diablo exhibits a simpler gyro property.

It will be noticed that when it is spinning on the string, instead of being an awkward behaving piece it settles down into a well-behaved spinning mass, holding its axis of its own accord rigidly in one direction. This property of holding its axis fixed in direction when spinning is so strong that it can be thrown to a height of forty to fifty feet by jerking the string tight, and then caught again, spinning on the string, but during all of the tossing and catching its axis remains pointed in the same direction. This toy demonstrates the first and most important principle of a free rotating mass or gyroscope. We call this property fixity of plane. Newton's first law of motion is, that a mass, if undisturbed, tends to continue in its same state of motion indefinitely. With a gyroscope or rotating mass, the equivalent law is, that if undisturbed it will maintain the direction of its axis fixed in space indefinitely. It is, of course, this same property of fixity of plane which keeps the axis of the earth pointing so steadfastly at the North Star as the earth rotates.

There is a second important property of the gyroscope which is called precession. It is this property which has contributed largely to the reputation of the gyroscope for uncanny and unnatural behavior and which has mystified people the most. Precession, however, may be considered the equivalent of Newton's second law of motion to rotating masses. It is the term for what happens to a rotating mass when it is disturbed or when a force is exerted about any of its axes. Newton's second law states that when a force is exerted against a mass, it no longer remains in its uniform state, but is accelerated. With precession, when a force is exerted on a rotating mass which tries to change its fixity of plane, the mass precesses. The peculiar part of this precession is that it manifests itself in a way quite surprising to us, who are more used to the response of non-rotating masses. If we push or exert a force on any non-rotating mass, it merely accelerates or yields in the direction that we push it. If we do the same thing to a rotating mass or gyroscope, it does not yield in the direction that we push it; in fact, it resists this push but yields or turns

on its axis in a direction at right angles to the push. It is this peculiarity of the gyroscope, of having any force exerted about it appear as a force or motion at right angles to the direction that was exerted, that creates the mystery.

During the time that the gyroscope was a toy of children and lords and ladies, the mathematicians adopted this plaything as their own toy and many scientific papers and even books, were published on the mathematics of the spinning top. There is no doubt the mathematicians had as much fun with the toy as the children and you will be interested in finding that even as late as the 1911 edition of the *Encyclopedia Britannica* the article on gyroscopes consists of about eight pages of mathematical formulæ on tops and spinning bodies with scarcely a word on any practical application of this device.

Among these mathematicians was the famous and versatile French physicist, Leon Foucault, who may be called the father of the modern gyroscope. You will recall that it was Foucault who first demonstrated the rotation of the earth by an earth-contained experiment. Previous demonstrations all depended on celestial observations, but Foucault in 1851 first demonstrated his ingenious pendulum experiment in the Pantheon in Paris. By swinging a long pendulum from the top of the dome of the Pantheon he proved that the plane of swing of the pendulum slowly changed with respect to the Pantheon. This change was due to the rotation of the earth carrying the Pantheon around with it, whereas the plane of swing of the pendulum remained unchanged. The rate of apparent change was exactly what it should be for a pendulum holding its swing at the latitude of Paris as the earth rotated about its axis.

Not content with this demonstration, however, a few years later Foucault again demonstrated the rotation of the earth, with even more refinement and by an entirely novel means. He constructed for the purpose a gyroscope so sensitively supported that when it was spinning it held its fixity of plane in space well enough to demonstrate the earth's rotation about it. It was Foucault who gave the name gyroscope to this device, and it is evident how the name reflects the purpose for which he built this instrument, as it comes from the

two Greek words "gyros" which means rotation, and "skopein" which means to view; in other words, an instrument for viewing the rotation of the earth.

It is a great credit to the skill of Foucault that he was able to make a gyroscope so well balanced and accurate that it maintained its axis fixed in space accurately enough to demonstrate that the earth rotated while the gyro axis did not. But even after this demonstration of the possibilities of the gyroscope, no practical applications were made for years. During these years, however, enough interest was manifested in the possibilities of gyroscopes so that we find occasional published dreams and even quaint patent applications for various uses of the gyroscope. But the electrical art had not yet progressed to the point where it was possible to make a gyroscope which would maintain its speed and this, of course, is an essential of a practical application. Not enough was understood about gyros to make these early patents of much more value than the mere rudimentary ideas that such practical uses might be possible. One of the most interesting of these was a patent by a Dutch Minister, Van den Bos, granted as long ago as 1885 for a gyroscope compass. The idea was there, but unfortunately the compass would have worked only on land, as the rolling of a ship would have made it useless.

It was in the field of steering torpedoes that the gyroscope first found practical application. The torpedo is a device for exploding a charge against a ship. The crude beginning of this effective weapon was called the outrigger torpedo which was, strange to say, actually successful to some extent during the Civil War. It consisted of carrying the charge to be exploded on the end of a long pole from a small boat and, under cover of darkness, running the boat up to the enemy's ship and exploding the charge against it. Frequently, also, blew up the small craft and the brave torpedoman had to rescue himself as best he could. The effectiveness of torpedoes, however, was so great that nations endeavored to find better means for sending them against the enemy than that of sending a man along with them. Various devices were tried for propelling the torpedoes, such as pulling wire from spools which were geared to the torpedo

propeller. One of these schemes was to utilize the inertia stored in a heavy flywheel by spinning up the flywheel to a high speed before the torpedo was released, and allowing this energy to propel the torpedo. An unlooked-for advantage was found in this flywheel torpedo, in that it had a tendency to go in a straighter line than any of the other schemes and it was immediately evident that it was the gyroscopic effect of the flywheel which kept the torpedo more nearly on its course.

Then came the development of compressed air engines which were more efficient than any of the previous schemes. In 1896 Lieutenant Obry, a young Austrian naval officer, developed a gyro control for the Whitehead compressed air torpedo and this was the beginning of the modern torpedo. In this country the development was made by Mr. Leavitt, who perfected the Bliss-Leavitt torpedo which had greatly increased efficiency in range over the previous types of torpedoes. He increased the radius of action by a bold piece of engineering in automatically burning a fuel directly in the pressure air current, thus greatly increasing temperature and efficiency. He replaced the reciprocating Whitehead engine with small turbines and the control gyro with the sensitive valves through which it operated the rudder was refined to a point which gave the torpedo remarkable accuracy.

The next field, and probably now the most useful and widespread application of the gyroscope, is the gyro-compass. The magnetic compass, which had carried the sailing vessels and wooden ships through the era of exploration and trade expansion, was fast getting into difficulty on account of the coming of steel ships. The steel caused serious errors in the magnetic needle and made it necessary to carefully compensate the magnetic compass for these errors by various magnets and iron spheres. The skilled profession of compass adjuster was created. But at best these compensators weakened the directive force of the earth's magnetic field and always called for readjustment to prevent errors and uncertainties from creeping in.

After 1900 considerable study and experimenting were made with a new principle of indicating the north which utilized the gyroscope. Mr. Sperry, after a great deal of experimenting, produced his first

gyro-compass in 1910. The Navy became much interested in the success of this machine because the modern battleship had become a "no-man's-land" for the magnetic compass. The huge masses of steel comprising the turrets and guns exerted a greater influence on the compass needle than the feeble magnetic force of the earth. Exhaustive tests of the gyro-compass were so encouraging that further development was made, and the Navy adopted this non-magnetic compass for its large battleships and submarines. The news spread fast of the development of this new type of compass which was dependent in no way on the earth's magnetic field and which pointed to the true north rather than the magnetic north. Soon all of the large navies of the world were equipping themselves with this new instrument, even before the beginning of the World War. During the war all of the participating navies navigated by gyro-compass so that by the time of the armistice the gyro-compass was a well-established navigation instrument. Up to 1919, however, all gyro-compasses were confined to naval use. They were highly developed, expensive pieces of equipment. To meet the demands of the merchant marine, it was necessary to simplify and make less expensive this piece of apparatus, without sacrificing performance. A difficult task, but now, ten years later, an idea of the success of applying the gyro to the merchant marine may be gathered from the fact that there are now over one hundred steamship companies who are navigating their ships by Sperry gyro-compass.

During these years of service in the merchant marine, the gyro-compass has added greatly to the services which it is performing for the navigator. The fact that the compass is non-magnetic and points true north is now only one of numerous advantages of the gyro over the magnetic compass. The main advantage of the gyro is its capability to serve as a master from which other very important accessories are operated. The gyro-compass always has had repeater compasses; that is, the master compass transmits its indication to various electrical repeater dials. This allows the master to be placed in a suitable location and only the repeater compasses need to be placed on the bridge. The next addition to the gyro-compass

family was the course recorder, which is a repeater that graphically charts the course of the ship, showing each minute deviation. The recording paper is moved by clockwork under the pen and the pen is shifted by the master gyro-compass. This instrument has been found to pay its way as insurance in times of emergency, where it faithfully records the facts at the time of a collision or other catastrophe. The truth of its record has already stood in court against the less accurate stories of other witnesses who have no verification of their actions.

The last and most important addition to the family is the gyro-pilot, better known as "Metal Mike." This instrument takes over the duties of the quartermaster or helmsman and holds the ship on whatever course it is set. Few people are aware of the fact that for several years now the *Leviathan* has been crossing and recrossing the Atlantic without having any man at the wheel, and it is only one of several hundred ships that are now navigating accurate courses without a human helmsman.

But the application of the gyroscope which excites the most interest is the gyroscopic ship stabilizer. That is the only application of the gyroscope, so far, that makes use of the tremendous precession forces which may be obtained in large, rapidly rotating gyros. The history of rolling ships and attempts to stabilize them is very interesting. The old sailing vessels were all very well stabilized. The stabilizer was the wind-filled sails which held the ship steady in the rolling sea very effectively. Here again the coming of steam vessels with the elimination of the sails and the tendency toward long, fine lines introduced excessive rolling as a serious problem for the first time. Many marine engineers turned themselves to the problem of decreasing the excessive rolling of these steamships. Dr. Frahm of Germany developed a system of anti-roll tanks which were tanks partly filled with water connected by pipes or siphons which would allow the water to flow from one side of the ship to the other and were so arranged that this water had a tendency to stay out of phase with the waves or rolling of the ship and thus tended to reduce the roll of the ship by this shift of weight. These tanks, however, were very

heavy, cumbersome and noisy, and at best they merely reduced the roll to some extent, but could not eliminate it.

Sir John I. Thornycroft of England attacked the problem from the point of view of having a large pivoted weight which worked in principle similar to the Frahm tanks; that is, it was swung from side to side by hydraulic apparatus in such a period that it tended to counteract the roll of the ship. This instrument also was heavy and needed considerable room for its installation, and, of course, the effectiveness of it depended entirely on how much weight could be afforded in the shifting element. But none of the water-tank or weight-shifting devices came into general use and the bilge keel was the only roll-reducing device which was generally utilized. The bilge keel, which consists of fins extending from the lower sides of the hull, by no means eliminates roll but reduces it to some extent by acting as vanes or dampers in the water about the rolling axis of the ship.

The first attempt to stabilize a ship by means of a gyroscope was made by Dr. Schlick of Germany. He designed and installed on board the *Silvanna* a large gyroscope which was caused to precess whenever the ship started to roll. This is the simplest arrangement of a stabilizing gyroscope and is called the passive type because it starts to act only after the ship has started to roll. Its use has not been continued. At this point Mr. Sperry took up the problem and developed his ingenious active type of gyroscopic stabilizer. This type has proved very successful and its performance never ceases to be a matter of astonishment to mariners and landlubbers alike who see its action for the first time.

The Sperry stabilizer is called the active type because, instead of allowing the rolling of the ship to precess the stabilizing gyro, a small or secondary sensitive gyro closes an electric circuit which causes the stabilizing gyro to be forcibly precessed by an electric motor. This motor precesses the gyro in such a direction and at such a rate that the gyro transmits to the ship's hull a force exactly equal and opposite to the force which the wave is exerting on the ship in attempting to roll it. Since the force of this wave is just neutralized, the ship stays on a steady keel, and as the

wave passes under the ship the gyro is forcibly precessed in the opposite direction to keep the ship from rolling in the other direction, so that when the next wave comes it again finds a ship on an even keel, and again tries to start the ship to roll. It is here that the secret of the success of the active gyroscope is evident. An unstabilized ship is a pendulum. No single wave makes it roll to any extent, but the continued impulses of wave after wave build up the roll of the ship. Now with the stabilizer if the ship is stabilized sufficiently to counteract the force of the first wave, then, of course, there is no second wave, but each succeeding wave is the first wave, so the ship never starts to roll. It is found from experience that a ship which is unstabilized might roll as much as forty degrees and can be held quite level by a gyroscope which only has the power of stabilizing for a five degree roll, which we will say is the increment that one wave may add to the ship's roll. Therefore we can see that the gyroscope can be made relatively much smaller in size with respect to the ship than one would normally expect and in practice it has been found that a rapidly rotating mass of 1 per cent of the ship's weight is sufficient to completely stabilize the other 99 per cent. There are now about twenty of these ship stabilizers in active and successful operation.

The gyroscope has also found several applications in aviation. The most important, probably, is the gyroscopic turn indicator, an instrument carried by all Air Mail pilots and also by all of the renowned trans-oceanic flight planes. This instrument consists of a small gyroscope spun by air which is so mounted that it is caused to precess rapidly if the airplane turns slightly from a straight course. A pilot by watching the instrument is therefore able to fly a straight course even though he cannot see any objects ahead or on the ground. This instrument is indispensable at night and in fog or clouds. It is the instrument which makes blind flying possible. Lindbergh claims to have flown hours by it without getting a glimpse of the ground.

Another use of the gyroscope in airplanes is for stabilizing the plane. Mr. Sperry produced the first gyroscopic airplane stabilizer in 1914 and was awarded the grand prize in France for its perform-

ance in that year. Airplane stabilizers have been in more or less use since then but, on account of the great improvement in the inherent stability of airplanes, the gyroscopic stabilizer has not been as essential as it was once thought that it would be. Now, however, with the scheduled flights of large planes over definite courses or airways and for tedious hours for the pilots, the gyro-stabilizer is undoubtedly coming into its own again, not as a safety measure to keep the plane steady and upright but as a device for relieving the continued strain on the pilot during long flights.

In looking back over the various applications in which the gyroscope has found a field of usefulness, it will be noticed that they all apply either to marine or aviation work. This is to be expected, since the properties of the gyroscope lend themselves especially to uses where something fixed or rigid is needed in an unsteady medium. The gyroscope either is used to indicate data such as the meridian or the vertical of some known direction for either marine or aviator, or else it is used to forcibly hold an unstable object, such as ship or airplane, in approximately a level position.

Now, however, Mr. Sperry has found a most ingenious use for the gyroscope which finally brings it onto the land. This latest application of the gyroscope is in connection with railroading, and is called the automatic track recorder. A gyroscope has been developed for mounting on a special railroad car for recording the evenness of the roadbed. Through a system of levers and pens which mark graphically red lines on a slowly moving sheet of paper, the gyroscope pen continually records the true vertical and a pen mounted to the car trucks records the angle or tilt of the rails. The first of these track recorder cars has now travelled over sixty thousand miles at rates from twenty miles per hour to seventy miles per hour and has faithfully recorded the levelness of track over every mile that it has been pulled. It, of course, saves a great deal of track inspection and surveying since these records are turned over directly to the section foreman who can seek out and repair the uneven spots from the charted record. —P. R. Bassett in *Tech Engineering News*.

CAPITOL DOME BUILT OF IRON

The recent story that a fire had seriously menaced the dome of the Capitol building in Washington is anything but serious to Henry E. Janes.

"That dome will stand," he said yesterday in his office at 101 Park Avenue, "in spite of fire, war, pestilence and famine until they take it down—and even then it will be a bit unwilling about going. My grandfather furnished the iron for that job, and he figured that was one contract that was good for all time. He built that to stay!"

Mr. Janes, who is over 70 and looks 60, is the third generation of Janeses in the business. Today they make steel cabinets. In 1860, when they did the Capitol job, they were iron contractors, and spent most of their time building furnaces and stoves.

The contract for the Capitol work came to the firm—then the Janes, Beebe Company—by competitive bidding at a price of six cents per pound of iron, as nearly as Henry Janes can remember. The structural iron pieces were all made in the old Janes foundry at Westchester avenue, between St. Anne's and Brook streets, in the Bronx, and shipped from there to Washington in thousands of small segments. The Bronx plant gave way to the wreckers about twenty years ago and the site is now occupied by the five-story brick building of the Bronx Refrigeration Company.

The present Janes was a small boy when all that was going on—more interested in sore toes and red tops than in ponderous domes for government edifices. But he does recall a general air of excitement around the old home when the job was awarded to his grandfather. More than 8,000,000 pounds of ironwork represented a huge sum of money and serious work in those days.

"I remember all the pig iron for that contract came in over the old New York Central Railroad direct to our plant, which was then away out in the country," he said. "We had never figured on anything as big as the job turned out to be, but we were fortunately equipped to supply the required pieces. I know grandfather could talk of nothing else for several weeks.

"The superintendent at that time was an old Scot—forgotten his name—a taciturn,

hard-bitten workman of the old school. He supervised every pound of work that went into the job and then absolutely refused to go down to Washington to see the finished job. Said he had done his part—didn't care how it looked or what happened to it as long as the iron beams and superstructure were all built to dimension.

"The dome, of course, is nothing but painted iron—8,909,200 pounds of it, according to the figures of Tom Walter, the architect. The terrific weight of that thing rising 300 feet in the air above the top of the building, which is 287 feet above the ground itself, created a pressure of something like 13,000 pounds to every square foot in the basement. The cellar walls were supporting a mere 51,000,000 pounds of weight. That gives you some idea of the size of our job, eh?

"The entire structure had to be tested, piece by piece, here in the foundry before it could be shipped. One time there was a piece too large to put in the freight car and granddad ordered it pegged down to the top of the car. A week later word came from Washington that the piece was missing. We made a new one and sent it along. Six months later a letter arrived from St. Louis saying: 'We have found a large piece of iron pegged to a freight car in the yard here, bearing your label. Please advise.' For all that time part of our national Capitol was wandering around the country on top of a freight car, and nobody noticed it!

"The contract was awarded some time in 1859, and while the work was progressing the civil war came along. The Union Government was hard pressed for money, of course, and in May, 1861, the order came to suspend work on the dome. We had made all the first pieces by that time, they would only go to waste if they weren't used, so we kept right on working, at our own expense.

"After the war it took a special appropriation by Congress to grant us the money coming to us from the time work was ordered suspended until the job was finished in 1863. For a while it looked as though I might fall heir to a piece of our national shrine, but no such luck. Uncle Sam paid in full."—*N. Y. Sun*.

PIONEER SHIPS OF THE ATLANTIC FERRY

In the history of the application of the steam engine to ships the establishment of Transatlantic Steam Navigation will always remain one of the great landmarks. The steam engine was entirely a British invention but its application for the purposes of ship propulsion took place almost simultaneously in America and in Great Britain. The names of Ramsey, Fitch, Stevens and Fulton belong to America; those of Miller, Symington and Bell to Scotland and ever since Fulton's "Clermont" made her first trip on the Hudson in 1807 and Bell's "Comet" began plying on the Clyde in 1812, the story of the steamship has been one of continued progress.

By 1830 Great Britain possessed over 300 steam vessels of a total of over 30,000 tons and America probably many more. But whereas the great majority of American vessels were to be found in the rivers and lakes of North America, many of the British vessels had been built for work in the open sea. In February, 1830, just a century ago, the British Navy started running vessels between Falmouth, Gibraltar, Malta and the Ionian Islands and this was the first long distance over-sea service run to a schedule. Ten years later on July 4, 1840, the first Cunard steamship "Britannia" left Liverpool for Boston and no Company can show a finer record of achievement.

But the Cunard Company was not the pioneer company and the "Britannia" was not the first Transatlantic steam ship. Three companies were already engaged in the traffic before the Cunard ships came on the scene and the most remarkable of the early ships was the "Great Western." If any vessel can be called the Pioneer Ship of the Atlantic Ferry—it is the "Great Western." During the three years 1838, 1839 and 1840, she crossed and re-crossed no fewer than 17 times and before she passed from the possession of her original owners she had made 74 double passages. Then, too, in 1838 and 1839, the "Sirius," "The Royal William," the "Liverpool," the "British Queen" also made voyages to New York and back and in 1840 the ill-fated "President," sister ship to the "British Queen," made her

maiden voyage. These vessels and the "Britannia" are the ships with which we are concerned.

It is often stated that the first steam vessel to cross the Atlantic was the "Savannah" which in 1819 made a voyage from Savannah to Liverpool. This vessel was built as a sailing ship of 350 tons. After she was completed a single cylinder steam engine of 90 h.p. was fitted to her. Her paddle wheels were constructed so that they could readily be taken in board and when she left America she had 75 tons of coal and a quantity of wood for fuel. Her voyage lasted nearly a month and during that time her engine was in use for less than four days. After her arrival in Liverpool she made a voyage to the Baltic, returned to America and there her machinery was removed and she became a sailing ship again. Exactly what was the object of fitting her with an engine does not appear. It certainly did not assist her greatly. Her voyage cannot even be regarded as even a particularly interesting experiment and it resulted in no advance. She was, it is true, enabled to go into and out of harbor under steam when she might otherwise be delayed, but the voyage of the "Savannah" can safely be dismissed as having no influence on the development of the ocean going steamship or the establishment of Transatlantic steam navigation.

About eight years later a Dutch owned steam vessel, the "Curaçoa" built at Dover, also made a passage across the Atlantic. This time the voyage was from Rotterdam to Surinam, in the West Indies, and it took 27½ days. The "Curaçoa" was only of 436 tons burden and from all we know of the machinery of the day it was quite impossible for her to have steamed anything like the whole distance. Both then and for many years afterwards steam vessels carried a good deal of sail power and it may be presumed that most of the voyage of the "Curaçoa" was done under sail. She did the same trip again in 1828 and 1829 and it would be of interest to have details of her voyages.

In 1833 the Atlantic was crossed by two steam vessels, H.M.S. "Rhadamanthus" and the "Royal William." The former in

April and May went from Plymouth to Madeira and thence to Barbadoes. Her log is to be found in the Public Record office and from that it can be seen that her engine was in use for about half the voyage. This was more or less a fair-weather passage and the "Rhadamanthus" undoubtedly found her engine of use. She was one of our first steam fighting ships and a vessel of about 800 tons with an engine of 200 N.H.P.

A few months later the "Royal William" also of about 800 tons crossed from Pictou to Cowes. Built in Quebec she had an engine of 200 N.H.P., which had been made by Boulton and Watt of Birmingham, and for a couple of years had been trading between Quebec and Halifax. She left Quebec, August 4, 1833, and arrived at Gravesend, September 9, having called at Pictou for coals and having put into Cowes. It is generally stated that her engine was in use for the whole of the voyage and if this was actually the case she was undoubtedly the first vessel to steam across the Atlantic. Her passage was made from West to East but whether she could have accomplished the return voyage from East to West we do not know. With proper precautions it was quite possible she could have done so except in very bad weather, but as she was sold to the Spanish Government there was no occasion for her to attempt the passage.

None of these voyages it will be seen had any connection with a considered scheme for establishing a regular line of steam ships across the Atlantic and at that period few believed that steam was ever likely to supersede sail. Though we could boast of some 30,000 or 40,000 tons of steam vessels this was insignificant in comparison with the 3,000,000 tons of sailing vessels. The project, however, had been entertained by a few enterprising individuals as early as 1825, when a company had been formed for promoting Transatlantic steam navigation but nothing was done toward building the ships.

If it is desired to credit any individual with being the pioneer of the Atlantic Ferry, that credit must be given to Junius Smith, an American lawyer. Born in 1780, Smith had a successful practice and came to England to fight a case on behalf of an American ship. This led to a long residence in England and from the law

he turned to commerce. In August, 1832, he crossed to New York in the sailing vessel "St. Leonard," the passage taking 54 days. He returned from New York in December in the packet ship "Westminster," which took 32 days to reach Plymouth. It was these two passages which gave birth to the idea of founding a line of steam ships and in a letter written in London, June 28, 1833, Smith said: "Thirty-two days from New York to Plymouth is no trifle, any ordinary sea-faring steamer would have run it with the weather we had in fifteen days with ease. I shall not relinquish the project unless I find it absolutely impracticable."

June 28, 1833, is thus a date worth remembering for Smith's letter is evidence from a sound business man of what the steam vessels of the day were considered capable and it marks the beginning of Smith's determined efforts.

If he is regarded as the pioneer, then the Company he formed "The British and American Steam Navigation Company" may be regarded as the pioneer company and as it turned out the very first steam vessel to leave Great Britain for New York with passengers sailed under the direction of his company. At first received with opposition and indifference, Smith's views gradually gained supporters; in Macgregor Laird, the brother of John Laird of Birkenhead, he found a most able and enthusiastic colleague and when the subscription lists were opened in July, 1836, capital was readily forthcoming and Smith was able to inform his New York correspondents that the company had contracted for the building of "the largest and intended to be the most splendid steamship ever built, expressly for the New York and London trade. She will measure one thousand seven hundred tons, two hundred feet keel, forty feet beam, three decks and everything in proportion. She will carry two engines of two hundred and twenty-five horsepower each, seventy-six-inch cylinder, and nine feet stroke. The expense of this steam-frigate is estimated at £60,000. These large undertakings require time to mature, but I think the business will at last be done effectually." The ship the company had contracted for, first called "Victoria" was the "British Queen." While Smith and MacGregor Laird had been busy in London two other companies

had been formed for a similar purpose, one at Liverpool and another at Bristol. The former owed much to the energy of the lawyer and engineer Charles Wye Williams, one of the founders of the City and Dublin Steam Packet Co., and the company was called the Transatlantic Steam Ship Co. At the time of its formation a fine vessel in Liverpool was being built for Sir J. Tobin and this was purchased and around her centered the hopes of the Liverpool promoters.

The Bristol Company may be regarded as almost the child of the Great Western Railway Company. It became known as the Great Western Steamship Co. and the ship was known as the "Great Western." Though great credit must be given to Paterson, the builder of the ship, to Maudslay, who built the engines, and to Captain Claxton and to Guppy, a Bristol engineer, the Great Western Steamship, like the Great Western Railway, will always be associated with the name of Isambard Kingdom Brunel, whose powerful intellect grappled with ease great problems which were beyond the capacity of lesser minds.

Of the "Great Western," the "Liverpool" and the "British Queen," we shall hear much later but it is necessary for a moment to pause and recall an incident without the notice of which no history of Transatlantic steam navigation would be complete. In 1836, when the three companies in London, Bristol and Liverpool were busy with their schemes, the British Association met at Bristol and Dr. Dionysius Lardner gave a public lecture. Lardner at that time was the high priest of popular science and was known widely for his writings and lectures. He was noted and afterwards became notorious, but nothing he ever said or did gained quite the same publicity as his remarks on the projected Atlantic liners. What he actually said and what he actually meant perhaps differed. He undoubtedly sounded a note of caution: said that in the then state of the steamship a regular service could not be made to pay without a subsidy and added something about the impossibility of the scheme. His criticisms were probably not based on any real acquaintance with the art of shipbuilding or of the progress of marine engineering and they should have produced no more commotion than a pebble dropped into the ocean. Instead of that

the effect was that of a boulder dropped into a pond, and every writer since has recalled—perhaps with a spice of cynicism—the false prophecies of this once distinguished man of science.

But Lardner's view not withstanding, nothing was likely to diminish the efforts of Brunel, Williams, Laird and Smith and by 1838 the "British Queen," "Liverpool" and "Great Western" were well advanced and had it not been for the unfortunate failure of Girdwood & Co. of Glasgow who were building the engines of the "British Queen," all three vessels would have crossed in that year. The failure of this firm, however, prevented the completion of the "British Queen" about a year and it was this that led to the dispatch of the "Sirius" in her place.

The following tables give data of interest. Some of this information has been obtained from a MS. account of the vessels and their performances compiled in 1841, which is today preserved among the Field Papers presented to the Library of the Science Museum a few years ago by Miss Gertrude Field, the granddaughter of Maudslay's distinguished partner Joshua Field.

All the vessels had the standard side lever engine so familiar to seagoing engineers of that time and all had rectangular flue boilers, but whereas the "Great Western," "Royal William," "Liverpool," "Britannia" and "President" used salt water in their boilers, the "Sirius" and "British Queen" were fitted with surface condensers as patented by Samuel Hall; though I cannot find it so stated, I think it is just to conclude that they were fitted with evaporators. The logs of the "Sirius" and "British Queen" show that the boilers were worked at about 5 lb. pressure and this was general practice. Though the ships dealt with may all be regarded as Pioneer Ships of the Atlantic Ferry, the "Great Western" was regarded as the ship which made history and Sir John Rennel in his presidential address to the Institution of Civil Engineers, 1846, referring to the first voyage of the "Great Western," said: "The success of this voyage across the Atlantic having exceeded the most sanguine expectations of its promoters, and indeed of the whole world, there seemed no bounds to the extension of steam navigation." Half a century before this the

TABLE I

"Sirius"	Cork	4.4.38	New York	23.4.38	2
"Great Western"	Bristol	8.4.38	New York	23.4.38	17
"Royal William"	Liverpool	5.7.38	New York	24.7.38	3
"Liverpool"	Liverpool	22.10.38	New York	23.11.38	5
"British Queen"	Portsmouth	17.7.39	New York	27.7.39	8 Westward
"Unicorn"	Liverpool	16.5.40	Halifax	30.5.40	1 only
"Britannia"	Liverpool	4.7.40	Boston	18.7.40	3
"President"	Liverpool	1.8.40	New York	17.8.40	2
"Arcadia"	Liverpool	4.8.40	Boston	—	2
"Caledonia"	Liverpool	1.9.40	Boston	—	2 out 1 home

TABLE II

DIMENSIONS

	<i>Length</i>	<i>Breadth</i>	<i>Tonnage</i>	<i>Builder</i>
"Sirius"	178	25½	703	Menzies
"Great Western"	236	35¼	1320	Patterson
"Royal William"	175	27	617	Wilson
"Liverpool"	223	30	1150	Humble & Melcrest
"British Queen"	245	40½	1863	Curling & Young
			2076	
"Britannia"	207	34¼	1154	Duncan
"President"	243	41	2366	Curling & Young

TABLE III

ENGINES

	<i>Cylinder</i>	<i>Stroke</i>	<i>Horse Power</i>	<i>Makers</i>
"Sirius"	60 in.	6 ft.	320	Wingate
"Great Western"	73½ "	7 "	400-750	Maudslay
"Royal William"			270	Fawcett
"Liverpool"	75 "	7 "	468	Forrester
"British Queen"	77½ "	7 "	500	Napier
"Britannia"	72 "	6 ft. 10 in.	440-740	Napier
"President"	80 "	7½ ft.	540	Fawcett

TABLE IV

VOYAGES OF SAILING LINERS AND STEAMSHIPS

1839

	<i>Average Outward</i>	<i>Average homeward</i>
Black Ball Line	33.17 days	22.12 days
Dramatic Line	30.12 "	20.12 "
Star Line	36 "	24 "
Swallow Tail Line	35 "	22.12 "
"Great Western"	16.12 "	13.9 "
"British Queen"	17.8 "	16.12 "
"Liverpool"	17.4 "	15.16 "
Averages Sailing Liners	34.1 "	22.1 "
Averages Steamships	17 "	15.4 "
Difference	17.1 days	7.13 days

unfortunate American pioneer Fitch had written of the steamboat: "The Grand and Principle object must be on the Atlantick, which would soon overspread the wild forests of America with people, and make us the most oppulent Empire on Earth." Fitch was the first person in the world to form a steamboat company and to convey passengers by steamboat and when we think of our magnificent leviathans of today, it is only just to pay homage to the work of those who prepared the way for the developments of later times.

In the first table the sister ships of the "Britannia," the "Acadia" and "Caledonia" have been included but not the "Columbia," as the last named did not make her maiden voyage till 1841. The "Unicorn" was a vessel purchased by Cunard to run between Halifax and Quebec. She was sent to Boston in May, 1840

and was actually the first ship of the Cunard Line to cross the Atlantic. She must not, however, be regarded as being one of the Pioneer Ships of the Atlantic Ferry.

It might have been of interest to show how it was the problem of the Atlantic, which first led to a demand for large steam vessels, how the competition of the steam vessels stimulated the improvement of the construction of sailing vessels, how each decade saw the steamship become larger and faster until today the fourteen days' passage of the "Great Western" has been reduced to the four days of the "Mauretania" and the "Bremen." Last year the blue ribbon of the Atlantic passed to another country but to this country alone belongs the credit for inaugurating Transatlantic steam navigation.—*Eng. Capt. Edgar C. Smith, R.N. for the New-comen Society.*

METAL WALLS ON NEW SKYSCRAPER

The coming of the steel and glass skyscraper of the future, its height limited by economic considerations rather than by structural difficulties, is being hastened by the use of sheet metal largely to replace brick and stone in the new Empire State Building now being erected here.

A silvery chrome-nickel-steel alloy in angular sections one-twentieth of an inch thick will form a large part of the walls of the building. The metal was first developed for gun linings and is unrusting, non-tarnishing and unaffected by weather.

Such thin walls are likely to be used for buildings of the future. Some architects feel stone and brick walls for skyscrapers are not in keeping with steel structurally and are merely a heritage. The metal is said to save floor space, cost less and weigh less, give more light and result in better health for the occupants. Glass would be used to such an extent that partitions and great portions of outside walls would be made of it.

This tallest skyscraper in the world being erected on the site of the old Waldorf-Astoria hotel at 34th St. and Fifth Ave. will be the nearest approach to the

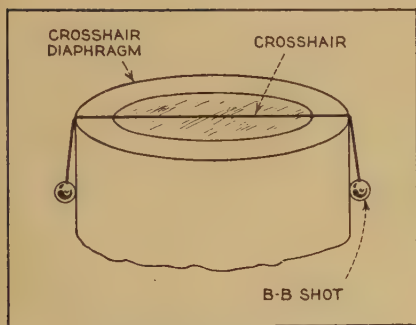
structural limit of 2,000 feet as determined by computations of the American Institute of Steel Construction. Its 85 floors will rise 1,043 feet high, and the building itself will be surmounted by a 200-foot observation platform or mooring mast for airships.

Eiffel tower rises 1,000 feet, the City Bank and Farmers Trust Co. will be 925 feet and the Bank of Manhattan 838 feet tall. The Chrysler building soars 808 feet and the Woolworth building 792 feet.

The enormous weight of elevator cables, the inability of the human ear to withstand rapid pressure changes in an elevator going faster than 1,500 feet per minute, and the large floor area needed for elevator shafts make it impracticable to exceed the approximate 2,000 foot structural height limit.

The economic height depends upon the cost of land, the Steel Institute says. Its studies show that where land value is \$200 per square foot a 63-story building brings greatest returns. Where the value is \$400 per square foot a 75-story building was found to be most economical.—*Science Service.*

REPLACING CROSS HAIRS



CROSS HAIRS FOR INSTRUMENTS

To replace the cross hairs on a sighting instrument the following procedure will be found simple and efficacious:

Select a fibre that will allow at least one inch overhang on each side of the metal diaphragm which contains the lens.

Fasten a BB shot on each end of the fibre by splitting and crimping it on.

Take hold of one of the shot and lay it across the diaphragm.

Fasten the fibres with a drop of shellac.

Clip off the extra ends.

This method stretches the fibre better than when a brass wire is used and holds it tight against the metal.—*Glen Morgan.*

LIFE OF WATER TANKS

WOOD ELEMENTS LAST LONGER THAN STEEL HOOPS

Because wood saturated with water decays slowly, if at all, it has retained its favor for tank construction since the simple equipment used by the Egyptians five thousand years ago. Probably no American industry is more dependent upon the use of tanks than the railroads which employ them in large quantities and big sizes to store water at terminals and along the right-of-way for locomotives. Thousands of such wood tanks are in continuous service and their record of usefulness over long periods contributes largely to successful railroad operation.

During a recent interview with an official of the Missouri Pacific Lines at St. Louis, Missouri, a representative of the National Lumber Manufacturers Association was told that cypress tanks have given consistently twenty-five to thirty years of service with but nominal repairs to the wood itself. The portion of the tanks requiring the most maintenance is the steel hoops around the tanks. These have to be renewed about once in every ten years—an actual record of wood outliving the steel

at the rate of one to three, under such conditions. The Missouri Pacific also uses redwood for tanks. Tanks of this species have been in service for sixteen years and are still in excellent condition. Wood tanks are used by the road in all places up to 100,000 gallon capacity. Wood has proven that in suitable thicknesses it is amply strong. No other natural material so well combines light weight, strength, economy, durability, non-permeability, low heat conductivity, acid resistance, workability with tools and universal availability.

A recent survey of railroad water tanks used by a number of different railroads shows an average life of about thirty years with many still remaining in service. The probability is that before all these tanks are replaced they will approximate forty years each. Out of 295 railroad water tanks, 174 are still in service on seven railroads, with an average life of 30.5 years and 121 water tanks (which have been relieved) on ten roads showed an average life of 27.5 years.

A NEW REFRIGERANT

In a paper presented before the April meeting of the American Chemical Society, Thomas Midgley, Jr., and A. L. Henne, associated with the General Motors Corporation and the Frigidaire Corporation, described a substance, the use of which as a refrigerant is new. This material goes under the name of difluoro-dichloro-methane. A gas at ordinary temperatures and pressures, it can be liquefied by compression, and upon being suddenly allowed to expand it exerts a cooling effect similar to other refrigerants. Moreover, difluoro-dichloro-methane is reported by the Bureau of Mines to be practically non-toxic in concentrations and under conditions which are ever likely to be experienced.

OPENING NEW FIELDS

It is not the thought of the authors of the paper describing this new refrigerant that it will replace any material now giving satisfactory service; they expect rather that difluoro-dichloro-methane will permit refrigeration to enter fields which heretofore have been largely closed to it, because of lack of a refrigerant having suitable properties. The cooling of bedrooms by means of difluoro-dichloro-methane has been mentioned. Its employment in mines to increase the comfort and efficiency of the workers is another use which has been proposed but which has been closed to previous refrigerants because of their toxicity or other objectionable properties.—*Industrial Bulletin, Arthur D. Little, Inc.*

SECRET OF "WOOD STRENGTH"

We are just beginning to find out something about why one kind of wood is strong and another is weak. This concerns the builder, manufacturer and consumer. The strength of wood as the strength of practically all structures from a piece of cloth to a skyscraper depends generally upon the way it is fabricated and the quality of the fabric.

According to the New York State College of Forestry at Syracuse University, one of the principal factors is the way fibers are distributed in the wood. Fibers uniformly distributed make for strength. The thickness of the fiber-wall also makes for strength. The density of wood tends to increase strength although very dense pieces of oak have been found for some unknown reason to be lower in strength than the moderately dense, but generally all species of low density are weak. The moisture in wood apparently affects its strength. Wood dried in the open air has a

"crushing strength" about fifty per cent greater than greenwood and wood dried in a kiln is about one hundred per cent greater. This is important in calculating the resistance of short columns to great weights. But the United States Forest Service states that in large timbers the increase strength attending the lower moisture content is often offset by checks and defects caused by seasoning. However, this rule does not apply to small, clear, well seasoned pieces.

The annual growth ring of a tree is made up of wood that has grown in the spring and summer. It is generally true that the greater the proportion of summer-wood, the greater the weight and strength of the timber. A normal growth in coniferous trees produces the best quality of wood. In the case of hardwoods, such as hickory and ash, fast growing with few annual rings to the inch makes stronger and heavier wood than slow growth.

REMOVING METAL SCALE

After years of experimentation, a firm in New England has perfected a method of removal of scale resulting from heat-treating and hardening operations on metals, not only from flat surfaces but from such intricate machine parts as gears, shafts, etc., as well as from cutting tools, such as drills, taps, dies, cutters and reamers. The scale is removed without in any way injuring the surface structure of the steel or metal part.

The process is an electro-chemical one, the descaling action being brought about by the generation of hydrogen on the work, at the same time protecting the work from hydrogen embrittlement or pitting by coating the cleaned work by depositing a metal on it. This coating remains on the

work, if it will not interfere with subsequent operations. It can easily be removed electrolytically if found to be undesirable.

This process makes it possible to do away with the hand work formerly necessary, like filing, sand-blasting, scraping and scratch brushing, and thus greatly reduces the labor cost. Further study is being made of the adaptation of this process to the special fields in the metal industry. It is expected that it will have very wide application.

The process is said to be so simple that only a small installation is required, embracing a motor-generator for the current and tanks in which the treatment is given. —*Industrial Bulletin of Arthur D. Little, Inc.*

BIGGEST GENERATORS OPERATE IN HYDROGEN

When engineers have made the largest electric generators possible, they will be able to still further increase the capacities of the huge machines another 25 per cent. by running them in an atmosphere of hydrogen gas.

The light, inflammable gas has already been used successfully with a small enclosed generator, M. A. Savage, of the General Electric Co., told the World Power Conference. Engineers have learned from its operation how to apply hydrogen to the largest units.

These data indicate that large generators can be built with efficiencies at rated load six tenths of one per cent. higher when operating in hydrogen and that the active magnetic material can be reduced some 25 per cent. for the same kilowatt output. Expressing this in another way, machines of 25 per cent. greater output will ultimately be possible when the limit in capacity is reached in air cooled generators.

Hydrogen cooling is a perfectly practical thing and its adoption will mark the

next big step in the increase in efficiency of these large units.

Although an increase in efficiency of only six-tenths of one per cent. seems very insignificant, if applied to the world's largest generator it would mean an additional capacity of more than 1,200 horsepower. The capacity of this one unit exceeds 200,000 horsepower and operates at an efficiency of about 98.5 per cent.

Hydrogen is more desirable than air as an atmosphere for generators because it reduces one of the machine's greatest losses, that caused by wind resistance. Hydrogen has only one-fourteenth the density of air. Just as it is easier for a cook to stir water than a thick cake batter, so the rotor of a generator turns more readily in hydrogen than in air.

Generators using hydrogen will be entirely enclosed and the gas will be under a pressure slightly higher than atmospheric. It will then slowly leak out around the rotating shaft and there will be no danger of an explosive mixture accumulating in the enclosure.—*Science Service.*

DESIGNING A NEW CAR

A SIXTEEN-CYLINDER CAR WITH MANY UNUSUAL FEATURES

The new Cadillac V-16 is of exceptional interest from the standpoint of the engineer as an illustration of how factors of design may be made to yield certain prescribed results from a performance standpoint. This article will discuss the V-16, the first sixteen-cylinder car to be put into regular production, as an illustration of how a design may be selected to meet certain demands and how, when the initial factors are once selected, the entire design is immediately interlocked. The principle becomes more pronounced as machines increase in size and complexity.

In order to understand the reasons underlying this particular design, we must first know the objectives which were set for the finished car. The automobile of today has reached an almost phenomenal degree of perfection and practically all cars give reliable economical transportation with a really remarkable degree of comfort. A definite demand exists, however, for a large car capable of exceptional performance in traffic and on the open road, with super-comfort. Such a car could obviously only be available to a comparatively small market and all consideration of price could be removed from the design at the outset. To secure such comfort, a car must be large enough to give adequate room for seating without crowding and have sufficient spring weight to give satisfactory riding qualities.

Both of these factors dictate a large heavy car. This car, to satisfy the particular market for which it was intended, however, had to have a greater acceleration, greater flexibility, and more satisfactory general performance than was formerly available. This, in short, was the problem confronting its designers; how to get performance in a large heavy car comparable to that of the smaller lighter cars available today which were considered to give exceptional performance but quite unsatisfactory riding qualities, too restricted space, and insufficient distinction for the type of buyer to which this larger car will appeal. The problem immediately resolves itself in a familiar law of physics $F = Ma$. The only solution can be to in-

crease the force available for acceleration. The problem is complicated, however, by other demands of modern traffic.

Acceleration must be available, not only at low speeds, but at high speeds in order that one may pass other cars going in the same direction at high speeds, a condition common on the highways of this country today. Higher speeds than those generally obtainable are also a prerequisite for such a car. But the resistance to be overcome at high speeds is largely that of air resistance and all the resistance encountered, that is, the total of head end resistance, rolling resistance, and the other atmospheric conditions such as skin friction and the vacuum effect at the rear of the car can be represented by a curve in which the resistance is approximately proportional to the square of the speed. This, in turn, makes the power required to drive the car proportional to the cube of the speed, a condition which obviously requires tremendous power if high speeds are to be obtained and if an adequate reserve power sufficient for acceleration at these speeds is to be provided. To be more specific, a seven-passenger sedan with a rear axle ratio of 4.75:1 will make better than 85 miles per hour and roadsters with an axle reduction of 4:1 will do better than 100 miles per hour, while great acceleration may be obtained at 60 miles per hour. These conditions necessitate a power plant of exceptional capacity.

The power output of an internal combustion engine is largely determined by its displacement. Greater power may be secured by making the cylinders larger, but this inevitably requires heavier reciprocating parts, reducing the speed of the engine and generally inducing vibration.

Greater displacement may also be provided by increasing the number of cylinders, thus securing the required additional power and at the same time obtaining a more continuous torque, smoother operation from more overlapping impulses and less stress on all rotating and reciprocating parts because of lighter impulses. This principle has been responsible for the present popularity of the eight-cylinder

engine, for the gradual displacement of the four-cylinder engine by the six, and in turn the six by the eight.

After a great deal of study, engineers finally decided on a sixteen-cylinder engine having a piston displacement of 452 cubic inches as most satisfactory for propelling this large car. The engine selected actually develops 175 brake horsepower with all accessory units in place and without the customary temperature corrections. This power is developed at a speed of 3400 r.p.m. and a maximum torque of 320 pound-feet is produced at 1400 r.p.m. The specific fuel consumption over the entire range of operation is approximately 0.6 pound per brake horsepower per hour.

A sixteen-cylinder engine would obviously have to be of Vee type construction to avoid excessive length and the many difficulties bound to occur with long in-line engines. The angle of the Vee is 45 degrees as this is the only angle which will give equally spaced power impulses. The angle of the Vee is determined by the accepted formula

$$\theta = 360 \div \frac{n}{2}$$

where θ = angle of the Vee
 n = number of cylinders.

The application of this formula gives 90 degrees as the correct angle for a Vee eight and 60 degrees for a Vee twelve. The bore selected was 3 inches with a stroke of 4 inches and compression ratio of 5.5:1, giving a maximum brake mean effective pressure of 160 pounds per square inch.

From these few general specifications dictated by the foregoing requirements of power and smoothness, the other factors of the design follow as a natural result, a striking illustration of the interdependence of design factors. With an included angle of 45 degrees the space within the Vee becomes too constricted to permit the use of an L head valve arrangement or the placing of carburetor and manifolds within the Vee.

Overhead valves were selected which in turn introduced another problem. This type of construction is generally subject to noisy operation which would be highly objectional and necessitated the development of automatic valve silencers which

will be explained in greater detail further in this article.

The crankcase which forms a base for the entire power plant is cast from a silicon-aluminum alloy and is ribbed to provide greater rigidity and stiffness. Great care has been taken in its design to prevent resonance which would tend to amplify and telegraph minute engine noises to the interior of the car. It is closed at the bottom by a cast aluminum oil reservoir of ten quarts capacity provided with exterior cooling ribs and transverse interior baffles to prevent surging of the oil when accelerating and decelerating. A copper water passage is cast into the rear of the case to permit water to pass from the single water pump at the right of the engine to the left cylinder block.

The cylinder blocks are nickel-iron castings and again are of unusual design dictated by the factors we have already considered. In order to secure satisfactory appearance and pleasing body lines the engine must be made to conform to the prevailing contours of radiator shell and hood. This has been secured in spite of the added height above the piston necessitated with overhead valves by permitting the cylinder barrels to extend into the crankcase as seen in the accompanying cross-sectional view of the power plant. This also tends to give a greater rigidity to the entire engine. Another engineering feature of interest is the method of mounting the cylinders to the crankcase so as to relieve the bores of all stress. A row of studs and acorn nuts holds the cylinder blocks to the crankcase on the side away from the Vee. The opposite side of the block is secured by studs extending through the cylinder block and also through the cylinder head, clamping the block securely between the head and the crankcase without stressing the cylinder barrels.

The design of the crankshaft was carefully considered so as to secure ample strength, freedom from torsional vibration and great rigidity. Five steel backed babbitt lined main bearings were adopted as it proved easier to lubricate five broad main bearings than a large number of narrow bearings. Furthermore, five bearings are more than ample to prevent deflection; they permit a shorter engine where space is at a premium and also give sufficient

room to permit removing any of the sixteen pistons and connecting rods without disturbing the cylinder heads. The total bearing length is 10 inches, which is approximately 25 per cent of the total length of the shaft. One of the most interesting features is the fact that the journals of the connecting rods overlap the main bearings by $\frac{1}{8}$ inch because of the unusually short stroke of 4 inches giving greater strength and rigidity. The main bearings are $2\frac{5}{8}$ inches in diameter, the connecting rod bearings are $2\frac{1}{2}$ inches in diameter, which with a crank throw of 2 inches gives the overlap already described.

The shaft is forged with crank throws in two planes giving inherent balance and is provided with four counterweights forged integral with the shaft. An harmonic balancer is provided at the front end of the shaft to completely dampen torsional vibration present in all shafts of more than four throws.

The connecting rods are chrome-molybdenum steel forgings with a center to center distance of $9\frac{1}{4}$ inches and a big end bearing $2\frac{1}{2}$ inches in diameter by $1\frac{1}{8}$ inches in length. The rods from opposite cylinders are placed side by side on the same crank throw, the blocks accordingly being staggered. The wrist pin bearing is a bronze bushing .75 inch inside diameter and $1\frac{1}{4}$ inches long. The big ends of the rods are lined with babbitt cast directly into the rod. Both ends of the rod are diamond bored to insure a perfect bearing surface.

The pistons are nickel-iron castings of light weight design, being used in preference to aluminum to avoid the difficulties of excessive expansion. Each piston is fitted with three compression rings and one oil control ring. The wrist pin is locked into the piston by a set screw preventing movement of the pin which might otherwise score the cylinder walls.

The valves are operated by a single camshaft equipped with 32 integral cams located at the base of the Vee. This shaft is a hollow steel forging and is supported by five bearings. It is driven by a Morse silent chain from the crankshaft, this same chain also driving the generator and the water pump. Chain wear is automatically absorbed by a spring actuated idler sprocket.

The cams operate the valves through roller cam followers, duraluminum push rods, and rocker arms. This mechanism, incorporating the automatic valve silencer already mentioned, differs from the conventional overhead valve engine in that each of the rocker arms oscillates on a bushing eccentric with respect to the rocker arm shaft. Rotating this bushing about its shaft draws the rocker arm down tight against the valve stem and the push rod, eliminating all clearance. This eccentric bushing carries an arm, as may be seen in the accompanying illustration, which bears against a small piston. This piston operates in a cylinder filled with oil and is constantly tending to rotate the eccentric under the influence of a small spring between the piston and cylinder head of the silencer. This action tends to eliminate all clearance, giving quiet valve action without the necessity of adjustment. When expansion of the valve stem takes place the eccentric bushing tends to rotate, forcing the piston into the cylinder. The oil in the cylinder escapes between the piston and cylinder wall and the small spring is compressed slightly, permitting expansion to relieve itself. Oil returns to the cylinder through a spring seated valve within the piston as soon as the conditions permit the piston to raise again.

The oil is used to prevent action of the piston with each movement of the valve, as it cannot escape past the piston rapidly enough to permit response to anything but continued pressure. In actual operation these parts move through only a few thousandths of an inch. Both intake and exhaust valves are of silichrome steel with a clear diameter of $1\frac{1}{8}$ inches. Double valve springs are used to eliminate valve spring surging and clatter at high speeds.

Oil for the engine is supplied under pressure to all bearing surfaces from a reservoir already described which is completely covered by a fine mesh copper screen.

The oil pump is mounted on the rear main bearing can and driven by spiral gearing from the rear of the camshaft. It delivers the oil under pressure to each of the five main bearings through a copper header from which it flows through drilled passages in the crankshaft registered with the main bearings, to the connecting rod bearings and through the rifle drilled rods to the wrist pin bushings. Oil is delivered

to the rear camshaft bearing from which it enters the hollow shaft and lubricates the four remaining camshaft bearings through holes drilled in the shaft. Overflow from the front of the shaft is supplied to the timing chains. An external A. C. oil filter mounted on the dash is supplied with oil under pressure and delivers clean filtered oil to the rocker arm shafts, from which it flows through the bushings lubricating them and then through passages in the rocker arm dripping on the automatic valve silencers insuring a supply of clean filtered oil to these important units. Oil drains back from the cylinder heads around the valve push rods into the reservoir at the base of the engine to be recirculated. Special packing is used to seal the valve stems, preventing oil from flowing down the stem into the combustion chamber.

All oil draining back into the reservoir must pass through the screen covering its entire area, already described. The oil pump draws its supply through a pipe extending below this screen. Oil is supplied to the engine through openings in the valve rocker covers of either side of the engine, draining into the crankcase around the push rods. Cooling of the oil is secured by cast aluminum cooling ribs on the underside of the reservoir. An oil pressure regulator for the entire system is provided on the timing chain cover plate.

Crank case ventilation to minimize the difficulties of oil dilution is secured by drawing air into the crank case from an opening on the left side of the engine which is fitted with an air cleaner. The crank shaft with its compensators acts as air pump drawing air into the case. Circulation is further assisted by directing the fan blast towards this opening. The only radical departure from accepted practice is the use of a thermostat to close the air inlet after normal operating temperatures are reached. This has been done so as to prevent oil vapors from being expelled from the case and has proved satisfactory since excessive dilution only occurs at low temperatures and under starting conditions.

Cooling is provided by a single water pump mounted on the right side of the crank case and driven through an extension of the generator armature shaft which in turn is driven by the timing

chain. This pump is of the dual delivery type delivering water in equal amounts to two outlets in the pump housing. One outlet is connected directly to the right cylinder block and the other outlet connects with the passage in the rear of the crank case already described to deliver water to the left block. The capacity of the system is seven gallons and with a radiator core depth of four inches provides adequate cooling. A belt-driven six-blade fan mounted on ball bearings and thermostatically controlled radiator shutters complete the cooling system.

Fuel is carried in a 25-gallon tank at the rear of the car and is delivered to each of the two carburetors through a separate fuel line vacuum tank and strainer. This provides two completely independent fuel systems, one for each bank of eight cylinders. Carburetors are 1½ inches single jet air valve units incorporating a throttle pump and thermostatic control as used on popular eight-cylinder cars.

The intake manifold is provided with a hot spot giving uniform heat under all operating conditions. Two carburetors were adopted and have provided better distribution than could be obtained with a 45 degree Vee in any other way. The difficulties inherent to distribution of gas to eight blocks have not affected the distribution in this system because of the unusually small displacement of each individual cylinder and the consequently smaller disturbance in the manifold during the inlet stroke of each cylinder. Vacuum for the vacuum tanks is obtained by a small vacuum pump driven from the rear of the camshaft. This insures adequate vacuum at high speeds when the intake manifold depression is not very great and gas consumption is at a maximum.

Two separate exhaust system have been provided with manifolds, mufflers and tail pipes for each block of eight cylinders. The exhaust manifold has been cast in three sections with expansion joints so as to prevent distortion of the cylinder blocks, and the cracking of manifolds from expansion. We have found this construction essential in blocks of this length.

The electrical system is of conventional design and Delco-Remy manufacture. The distributor is provided with a breaker mechanism containing an eight-lobed cam and two sets of contact points. Two con-

densers and two coils are also provided. The coils have been mounted in the top of the radiator, a rather unusual location, so as to obtain low temperatures and short leads to the distributor. The wires from the ignition switch on the instrument board are led to the coils through the radiator brace rods. The spark plugs are placed in the Vee and located in the combustion chambers between the inlet and exhaust valves. One plug is used for each cylinder.

The design of the chassis requires great consideration to insure adequate strength and rigidity with an engine of this size and power. A wheelbase of 148 inches was adopted with a total spring base of 102 inches on each side, representing 64 per cent of the entire wheelbase. The frame channel section is nine inches in depth and of 5-32 stock giving unusual strength. The suspension of the engine in the frame is unusual in that a five-point suspension is adopted to effectively absorb the torque reaction and prevent undue stress in the power plant.

Two mountings are placed on the front end cover, two on the flywheel bell housing and the fifth at the rear of the transmission. All mountings are made with rubber connections absorbing shock and vi-

bration. The axles, clutch, transmission, spring and other units follow conventional design, being necessarily heavier and stronger to effectively handle the power of this engine.

To provide speed such as is found in the V-16, adequate brakes were a necessity. Our experience indicated the type of brake employing an articulated shoe and floating cam would be entirely satisfactory if excessive pedal travel caused by expansion could be minimized. This has been accomplished by changing the mechanical advantage of the pedal employing a vacuum assister to assist the operator in applying the brakes. This assister is simply a diaphragm which is connected to the vacuum in the intake manifolds through the brake pedal to give additional force. The force of the assister is at all times directly proportional to the effort of the driver upon the pedal preventing severe brakes and unpleasant braking action.

In conclusion, this article is only a brief resume of the salient points of the new V-16. The writer has attempted as far as possible to show some of the problems which have to be met in designing a new automobile of certain prerequisite capabilities and how some of these problems have been overcome.—*A. K. Stricker in Tech Engineering News.*

NATIONAL HYDRAULIC LABORATORY

The National Hydraulic Laboratory, authorized in a bill passed by Congress and signed by President Hoover, will probably become a reality next spring.

An item granting \$350,000 for its construction is in the Second Deficiency Appropriation bill which has just been reported to the House from the Appropriations Committee. This bill is expected to pass the present session of Congress and make the funds available about July 1.

The laboratory is to be built at the U. S. Bureau of Standards here. It is largely the result of efforts of prominent engineers for a number of years who claim it will greatly advance the construction of large hydraulic works in this country.

Necessary tests would be conducted in the laboratory before big engineering proj-

ects such as dams or sluiceways are undertaken, Dr. George K. Burgess, director of the Bureau of Standards, explained in committee hearings. Studies of sedimentation would be made when it is planned to put obstructions in rivers, and other experiments of this kind would be carried out to direct engineers to the best solutions of their problems.

"This will be a service laboratory for the departments having field work in hydraulics," Dr. Burgess said, "principally the Reclamation Service, the Geological Survey, the Corps of Engineers of the Army, and the Bureau of Roads of the Agricultural Department."

The Reclamation Service has already submitted a list of urgent problems that will take the laboratory months to solve. Laboratory studies of value to Boulder Dam will also be made.

CRUDE OIL AUTOMOBILES

Automobiles without ignition systems and averaging 25 miles on a gallon of six-cent crude oil are not far distant. A Diesel engine which accomplished these economies was recently operated successfully in a seven-passenger sedan and a roadster, C. L. Cummins, of Columbus, Ind., reported to the Society of Automotive Engineers.

The widespread use of this kind of engine depends on additional technical perfection, experts say, which should be accomplished through scientific research during the next few years. In Europe, where the cost of gasoline is very high, the Diesel engine is already being applied to trucks and motor buses.

Plans were announced to put such an engine on the market in America. It will compare favorably with present day standard gasoline engines in truck and bus service, and should carry the Diesel engine into the automotive field very fast.

The engine used in the sedan and roadster was designed primarily for marine service, but after being adapted to the automobiles it performed unusually well. During the entire 6,000 miles the sedan was driven its performance was practically the same as with standard equipment originally used. The only noticeable difference was a little sluggishness on the

pick-up from zero to 20 miles per hour. Top speed was 55 miles per hour.

The same engine in the lighter car made a speed of 88 miles per hour and acceleration was better. It took four passengers up Lookout Mountain at Chattanooga in high except over two rough spots.

In spite of this excellent performance much development must be done before the Diesel will be suitable for use in the ordinary passenger car. Its cost and weight must be reduced and it must be made more flexible.

The Diesel has been used primarily in small stationary power plants, locomotives and ships. Its weight per horsepower has been many times that of the automobile engine and its speed constant and slow.

Research has accomplished much toward making an automobile power plant out of the original slow-moving monster. In fact, several airplane engines have been developed, but their economies of weight cannot be applied to the automobile because they are radial type motors.

In high speed Diesel engines crude oil is injected into the cylinder just as it is needed for explosion. It is finely atomized as it enters through a minute hole under a pressure of thousands of pounds per square inch. Ignition is produced by the great heat of compression.—*Science Service*.

“CABAL”

During the tenth year of his reign, Charles II of England was surrounded by a ministry unprincipled in character and pernicious in counsel.

Their names were Clifford, Ashley, Buckingham, Arlington, and Lauderdale. The initials form the word cabal, a term which, from the character of those men, has since been employed in politics to designate a secret and dangerous association. It was an odd coincidence that the initials of the English cabinet officers formed the

word cabal. That word, however, well known before any of those men were born. Etymologists trace it to the Hebrew gabbalah. As early as 1656 the word was already used in its modern sense. In that year Cromwell is recorded to have said of a certain man that “he had never been at any cabal.” In 1646 also, according to Clarendon, Charles I had “asked of a certain man whether he were engaged in any cabal concerning the army.”

HYDROGEN COOLING

Hydrogen cooling, by which it becomes possible to reduce electric losses to about 75 per cent of the value obtained with air-cooled equipment, is to be used with a 50,000 kv-a. synchronous condenser which is being constructed at the Schenectady works of the General Electric Company for outdoor installation at the La Fresa substation of the Southern California Edison Company. Totally-enclosed, hydrogen-cooled synchronous condensers have been built previously by the General Electric Company, but none have approached the new unit in size or capacity. It is rated 50,000 kv-a., 13,200 volts, 600 r.p.m., three phase, and 50 cycles. The excitation will be furnished by a separate motor-generator set with a pilot exciter.

A synchronous condenser is a rotating machine that improves the quality of electric distribution by neutralizing some of the wattless current that flows over the lines. Induction motors and other equipment on a line cause such current to flow. When wattless current is neutralized by synchronous condensers, more nearly full capacity of the generating equipment becomes available. Additional useful load can then be carried without increasing the generating and distributing equipment. The effect of synchronous condenser is, in a way, like that of the condensers in a radio set which neutralize the inductance of the coils in the set. In the case of radio the most delicate balance is sought; on electric power lines, however, such a complete correction would not be desirable.

The advantages of hydrogen cooling are numerous. Not only can losses in a machine be decidedly decreased, but, if desired, the capacity can be increased for a given size of machine. Oxygen and dirt are excluded by the air-tight casing. Hydrogen will not support combustion, and fires of any kind—even from short circuits—are consequently impossible. Hydrogen also greatly reduces the effect of corona on the insulation.

The totally-enclosed, hydrogen-cooled machine is exceptionally quiet in operation, and so may be installed in residential districts where noise would be objectionable.

In the case of air-cooled equipment there is considerable loss in operating efficiency because of the resistance of the air against the rotating element. Hydrogen is much lighter than air, and the wind resistance loss is reduced to about 10 per cent of the loss in air if the hydrogen is used at atmospheric pressure.

The condenser is enclosed in a gas-tight, explosion-proof cylinder, provided with end bells. An extension on one end of the casing encloses the slip-ring mechanism. A seal is placed around the shaft where it enters the housing, so that the brushes may be adjusted or replaced without losing hydrogen from the main shell. The bearings are supported by structural steel frame-works welded to the inside of the casing.

Hydrogen, a good heat conductor, removes the heat much more rapidly than would air. The heat absorbed by the hydrogen is removed by four internal surface-type coolers, consisting of nests of pipes arranged concentrically inside the shell and close to each end of the casing. Hydrogen is drawn in along the field structure by fans placed at the ends of the shaft, and is forced radially outward through ducts in the armature laminations. It then passes back along the inside of the shell to the coolers, after which it is again drawn into the machine by the fans and recirculated. The cooler pipes are supplied with circulating water.

A pressure-regulating switch and valve maintain the hydrogen pressure sufficiently above atmospheric pressure so that leakage, if any, will be outward, thus preventing the contamination of the gas by air. A recorder in a cabinet attached to the casing gives a continuous indication of the purity of the gas, and operates an alarm if the purity falls below 91 per cent.

The condenser is kept so tight that the loss of the gas is negligible. Any loss is made up by hydrogen that is automatically drawn from a commercial cylinder of the gas connected to the piping system. Since a hydrogen and air mixture containing more than 70 per cent of hydrogen by volume is non-inflammable, there is an ample factor of safety against ignition of the cooling medium. As an added precau-

tion, however, the casing is strong enough to withstand the disruptive force of the most explosive mixture of hydrogen and air.

Oil-pressure starting, and indicating thermometers on the bearings are other features of the equipment. The thermometers operate an alarm if the temperature exceeds 140° F. Another thermometer, indicating the temperature of the hydrogen

as it leaves the cooler, rings an alarm if that temperature exceeds 104° F.

Hydrogen cooling of synchronous condensers has occupied the attention of electrical engineers for a number of years. The General Electric Company has done extensive research work in this field, and previous installations of smaller hydrogen-cooled condensers have been in successful operation during the past two years.

SHIPBUILDING IN AMERICA

Although our merchant marine is still far below what the national interests require, it is nevertheless encouraging to learn that during the quarter year ended March 31 the United States advanced from fifth to third place in ship construction. In the period ending December 31, 1929, we were outdistanced by Japan, Holland, Germany and Great Britain. Our tonnage was 179,062. For the quarter just ended, our tonnage was 222,974, the only nations ahead of us being Germany, with a tonnage of 231,162, and Great Britain and Ireland, with a tonnage of 1,614,993. The largest item in our advance is in tankers, of which we built 73,960 tons in the quarter just ended, as compared with 28,700 tons in the previous period.

Although British building for the last quarter is about five times as great as ours, it should be realized that only about two-thirds of that building was purely on her own account. Shipbuilding is a great British export industry. For the quarter ended January 1, 1930, Great Britain built a grand total of 1,544,000 tons. Of this total about 530,000 tons was built for other countries, leaving about 1,000,000 tons for Britain herself. Of her grand total 41,776 tons were built for the United States; 50,000 for France; 12,000 for Italy; 27,794 for the Netherlands; the colossal total of 224,083 for Norway; 42,969 for Sweden; 90,000 for Brazil; 8,600 for Honduras; 15,650 for Chile; 10,000 for Greece, and 7,000 for Jugoslavia.

Few Americans probably realize how many American ships are constructed outside of the United States. The days of our shipbuilding supremacy, although long since past, seem to have left the impression that we still build all our own ships. Yet apart from the 40,000-odd tons built for us in Britain, Italy is credited with building one ship for American use of 11,941 tons, Germany with three totaling 33,882 tons, and Denmark with one of 10,000 tons.

The British total for the quarter just ended so outdistances our gain that it may well be wondered when we shall ever approach it. Apart from construction, the British have about double our number of Merchant ships in operation. It seems to be a case of the small dog chasing the big rabbit, with the rabbit gaining at every leap. If present conditions continue, Great Britain will be gaining on us yearly, and at infinity will be much farther ahead of us than she is now.

But this need not discourage us. At present about 30 per cent of our foreign trade is carried in American bottoms. For safety's sake in another European war, this proportion should be much higher. But it is assuredly better than 1914, when only 8 per cent of our trade was carried in American ships and when we were absolutely helpless when it came to carrying our own goods. We must keep on building, and it is gratifying to note that we are doing so.—*N. Y. Herald Tribune.*

SHIPPING POWER BY BOAT

For several years the attention of power plant designers has been focusing more and more on economy in investment. The development of efficiency due to higher steam pressures and temperatures has rendered plants built for twenty years' service entirely obsolete in less than half that number of years. It is also recognized that changing conditions in certain communities are responsible for rather rapid variations in the demand for power. These changes require expenditures of largesums for transmission lines or else construction of new power plants which in a few years may be of no further service. These conditions are particularly difficult to meet in regions where there is considerable hydroelectric power which in times of drought requires the aid of steam driven auxiliaries.

Faced with these conditions the New England Public Service Company, which supplies power to a large portion of Maine and New Hampshire, particularly along the seaboard, has after an extended investigation resorted to a novel development which will be of great interest to all students of public utility economics. They are converting the 7,000 ton cargo ship *Jacona* into a floating power plant of 20,000 kilowatts capacity by the installation of new oil fired high pressure boilers, two 10,000 kilowatt turbo generators and all the refinements of the most up-to-date central station power plants. Although the New England Public Service Company has had this idea of a floating power plant under consideration for a period of more than two years, the attention of the general public was first called to a service of this sort during the past year when the airplane carrier *Lexington* was used for thirty days to boost the power supply of the city of Tacoma, Washington. In this case a severe drought reduced the supply of hydroelectric power available so that power service was seriously threatened. By special dispensation from the Navy Department the *Lexington* was docked at Tacoma and the energy of her turbines was used to supplement that of the city power plant.

Although the investment in the New

England floating power plant will represent over \$1,000,000, it is anticipated that it will be available for nearly twice as many hours of service in the course of a year as would any equivalent stationary power house. In addition there is a large saving in cost of transmission since the plant can be located at any convenient harbor along the coast nearest to its main load. Not only the cost of transmission lines but the losses of power, which frequently run as high as 20% on long lines, will be avoided.

While the cost of this power plant is not strictly comparable with the cost of a new power plant of conventional type built on land, due to the fact that the purchase price and cost of the conversion of the hull of the *Jacona* to the special needs of this service were probably less than the cost of building a similar floating power house for this specific purpose, there are, however, a number of important economies in a situation of this sort. Among them could be mentioned the decreased cost of the condensing water system due to the fact that the supply of condensing water completely surrounds the power house and also the lower cost of equipment foundations resulting from the mass effect of the water supporting the hull of the ship.

Whenever there is a shortage of power at any point along the northern New England coast, it will only be necessary to tow the *Jacona* to a suitable berth, make an electrical tie-in to the high tension system at that point and provide for the delivery of fuel as required. The vessel carries sufficient evaporative capacity to distill all necessary make-up water for its boilers. Thus a supply of power up to 20,000 kilowatts can be made available in a matter of a few days, as compared with weeks for building a transmission line or months for erection of a new plant, and at a tremendous saving in investment.

The fundamental advantages of this floating power house may be completely summarized in the one word "flexibility." The concept is modern in the extreme.—*Industrial Bulletin, Arthur D. Little, Inc.*

ELECTRICITY IN 1929

Electrical engineering still growing rapidly, rarely pauses for reminiscence—a habit of industries, and people, whose glory lies behind them. Recently, however, historical celebrations have turned men's eyes briefly to the past; to Brush, and his arc lighting; to Edison, whose practical incandescent lamp laid the foundation stone of an industry; to Westinghouse, whose alternating current made electricity for all purposes universally available.

We may wonder what aspect of our 1929 achievements would most impress an engineer of the 'nineties brought suddenly from that remote antiquity of thirty years ago. Most conspicuous would be the fabulous size of turbine generators, transformers and circuit breakers. Less obvious, but perhaps quite as impressive, would be the high modern efficiencies—the work of a generation of designers in chipping away the barrier of losses between their product and perfection, a barrier now sometimes less than one-half per cent. Amazing, too, would be the shrinkage of physical bulk brought about by high speed, ventilation and new materials; marked by such powerful pygmies as the 1250 hp., 3600 rpm. motor that could be put under a kitchen table. Besides these developments, whose origin he had witnessed, he would see others whose very principles are new, like the De-ion circuit breaker, the lightning investigations, and the new porous block arresters. Then, too, are the human attributes of voice, of hearing, of sight and of touch, which have come to electricity in the wake of radio and its kindred tubes.

But perhaps none of these things would strike our visitor from the past so vehemently as the change which has occurred in the main objective. In his day, the making and distribution of power was the great problem. That problem solved, the focus of attention now shifts to wider use, better adaptation to the needs of industry, and such are preponderantly the achievements which follow.

High in airplanes or deep in mines, handling blocks of steel or gossamer silk, driving ships and railways and street cars, heating massive castings or a spoonful of water for a dentist's spray, aiding the

labor of the family laundress or the diagnosis of the heart specialist, electricity is doing what has not been done before. Industry realizes, sometimes dimly, the promise of electricity. It is the opportunity of today's engineers to make good that promise.

H. W. COPE, *Asst. Dir. Eng.*
Westinghouse Elec. and Mfg. Co.

SOME ACHIEVEMENTS

The history of material progress and invention swings back and forth between fundamental discoveries and the practical application of these discoveries. First comes a period during which basic changes are introduced one after another. Then follows a period of catching-up, during which practical applications are made, further refinements are introduced, and the results are put to the service of mankind.

The progress of the electrical industry in the year 1929 perfectly illustrates the second half of this cycle. The year has been, commercially, the greatest year in history. There have been countless refinements in design and application of every type of apparatus; and many earlier products of research have now become important factors in commercial activity. The dollars-and-cents value of research has been demonstrated again by the fact that more than 20 per cent of the total income received was for electric apparatus either unknown or of negligible commercial importance only ten years ago.

A brief description of a few of the more important achievements of the past year is here presented.

POWER GENERATION

A 208,000-kilowatt, triple, cross-compound turbine-generator was completed for the State Line Generating Company (supplying power for Chicago) and has been in operation for six months. This is the largest self-contained power-generating unit ever built. An idea of this unit's capacity may be obtained from the fact that only two central stations in the Chicago district exceed it in output—and one of these stations contains six units, while the other contains fourteen.

A 160,000-kilowatt, tandem-compound

turbine-generator is now operating in a New York Edison Co. station. Contrary to the usual practice with extremely large turbines, there is only one generator in this unit, and it is the largest generator of any type ever built.

Four 77,500-kv-a. waterwheel generators are under construction for the huge Dnieper River development in Russia. These do not incorporate any radical departures from conventional design, but the mere fact of their huge size makes them interesting. The power-development project for which these are being made is the largest in the world.

Of great importance as regards future power-generation practice was the increased use of turbines designed for operation at steam pressures of 1200 pounds and up. Heretofore, the usual pressures have ranged around 400 to 600 pounds. It is well known that high-pressure turbines are satisfactory mechanically and will give economies in fuel consumption. The successful operation of these pioneer units therefore indicates a steady improvement in efficiency in power generation for the future.

ELECTRIC SHIPS

The launching of the *S.S. Pennsylvania*, the last of a fleet of three turbine-electric passenger ships for the Panama Pacific Line of the International Mercantile Marine, marked an epoch in our maritime history. The successful operation of this fleet has proved beyond doubt the value of this type of propulsion for commercial ships. At the present time, propulsion equipment for many other ships, ranging from car ferries and yachts to transoceanic vessels, is under construction.

AERONAUTICAL EQUIPMENT

In the application of electricity to aeronautics, great strides have been taken by commercial aviation during the last few years. Especially important is the magnet compass, which indicates the slightest deviation from the course that has been set and is now being manufactured on a commercial basis. The radio altimeter greatly reduces the dangers of blind flying in fog or clouds. This altimeter not only gives scale indications of altitude, but begins to warn the aviator at an altitude of 200 feet, by definite signals as the plane approaches the ground.

Last year, the development of an electric gasoline gauge, which measures accurately the amount of fuel in the tanks while the plane is in flight, was announced. This gauge solves one of the most difficult problems of the aviator. The gauge has been further improved and soon will be commercially available.

Two other aeronautic accessories of great importance are a thermocouple indicator, which records instantly and accurately the temperature of the engine, and an oil immersion heater designed to bring the lubricating oil to operating temperature very quickly.

Superchargers, developed some time ago, are now being widely adopted for use on engines of commercial and military planes.

RAILWAY ELECTRIFICATION

Great advances in railway electrification have been made during the last year, and new records were achieved in the number of orders for electric and oil-electric locomotives. The most important steam-road electrification projects are those of the "West Side" tracks of the New York Central in New York City and of the Delaware, Lackawanna and Western suburban division operating out of Hoboken, N. J.

The New York Central project involves the complete elimination of steam traction from Spuyten Duyvil south. Forty-two large electric locomotives are being built for this service, and 39 oil-electric equipments for switching locomotives are also under construction.

The Lackawanna project, which was announced last year and is proceeding steadily toward completion, involves the construction of 141 complete cars and necessary substations. In all, 132 miles of track will be electrified.

Gasoline-electric railway cars have found increased use in branch-line service; and a number of notable improvements in street-railway equipment have been made, all of them tending toward lighter construction, greater safety, and increased comfort for passengers.

ELECTRIC WELDING

The use of electric arc welding is steadily increasing. Many new applications of welded construction were investigated, one of the most unusual being in fabricating the floors of tall buildings. The weight of

floors has heretofore been a limiting factor in building construction; and the use of steel "battleship type" floors should greatly simplify the problem, because of their comparatively light weight.

ELECTRIC REFRIGERATION

In the promotion of domestic electric refrigeration, 1929 was a record year. Many new commercial uses for electric refrigeration (in dairies, ice-cream cabinets, water coolers, etc.) were also investigated and promoted.

RESEARCH

An interesting development of the research laboratory, which promises to become of immense commercial importance, is the film phonograph. In this mechanism, a continuous band of film records the sound; and, because of the compact nature of this record, it should eventually be possible to place a program of several hours' duration on one film. This work has not yet reached the commercial stage.

Extensive research in the characteristics of lightning was continued during the year, using natural lightning, and artificial lightning as high as 5,000,000 volts. The result was a far better knowledge of the effect of natural lightning on transmission lines and other electric apparatus.

BROADCASTING

Developmental broadcasting stations during 1929 have further demonstrated the reliability of long-distance transmission. Events in connection with the round-the-world flight of the *Graf Zeppelin* were on three occasions broadcast through Station W2XK, Schenectady, to European stations, where the programs were rebroadcast. Station W2XAF and W2XAC were used regularly for transmitting to Commander (now Rear Admiral) Byrd and his party at Little America. A special directive antenna is used in conjunction with this service to insure reception in this far-

off region. Station W2XCW was used in the development of television.

SUNLAMP

An outstanding accomplishment in lighting was the production of the Sunlamp. This lamp, designed for domestic use, is a safe source of those ultra-violet rays which give high therapeutic value to sunlight, and is already enabling thousands to enjoy the beneficial effect of these rays.

STREET LIGHTING

Last summer, General Electric completed the lighting of Woodward Avenue, a central street in Detroit's business district. This installation gives Detroit the honor of possessing one of the best-lighted streets in the world.

INDUSTRIAL APPLICATIONS

The year has been noteworthy particularly in the increased use of electric heating and the application of motors to new and unusual uses. An interesting installation is that of the electric equipment for an immense electric shovel now in service for the United Electric Coal Co. at Duquoin, Ill. The scoop of this shovel is so large that it could serve as a garage for an automobile.

Industrial power generation has set a new record in the 110,000 kw. turbine-generator for the Ford Motor Company. This will be the largest generating unit in industry and the largest for 1200-lb. steam pressure in the world.

Many other accomplishments of the greatest importance to the electrical industry—such as further work on vacuum tubes, the development of greatly improved transformers, the successful operation of high-capacity oil-filled cable, and further improvement of automatic stations and switch gear in general—are all worthy of mention but are too technical for description in this review.—*General Electric Pamphlet.*

ELECTRICITY IN THE HOME

Next to the electric light the most common household electrical appliance is the flat iron. Of the 19,721,000 wired homes in America 94 per cent have the electric iron. The figure is vouched for by the Electrical World.

Vacuum cleaners come next with 43.6 per cent of the homes equipped. Only a third of the homes have electric washers while electric fans, one of the greatest boons in hot weather, are in but a little more than a fourth of the homes that

might have them for added comfort.

Toasters are in 37 per cent of the homes and heaters in 16 per cent. Mechanical refrigerators are owned by less than 10 per cent and electric ranges by but 4.4 per cent.

Great as have been the strides in bringing electricity to the relief of housewives, it is apparent that only a start has been made. The field for electrical equipment far from being covered is still largely open.

ALTERNATING CURRENT TRANSFORMER

The supply of electric power and incandescent light had started in 1882 with Edison's direct current system, but 110-220 volts pressure, it soon became evident, was not practicable for the supply of large areas, and many people were fumbling about for some new answer. Gaulard, a Frenchman, and Gibbs, his English backer, were in Europe, in 1885, struggling to advance their new system, employing a high voltage alternating current line, with transformers connected in series on the primary side. They had made little progress; the connection being fundamentally faulty, and the devices primitive.

In that year, 1885, Westinghouse acquired this system, and at once set about making it practical. March 16, 1886, the first operative A. C. transformer installation in America began operation at Great Barrington, Mass. The first commercial plant was in Buffalo, New York, Novem-

ber 30, 1886. Other installations followed fast.

Furious opposition at once developed, fomented by those whose fortunes were tied to the use of low voltage direct current. Paid agitators toured the country "rousing the people" against the "deadly Westinghouse current" of 1000 volts. Edison, in the North American Review of November, 1889, said "There is no plea which will justify the use of high alternating currents, either in a scientific or commercial sense. . . . My personal desire would be to prohibit the use of the alternating current." Live stock was electrocuted before state legislatures; the electric chair in New York was cited as a further proof of the deadliness of the Westinghouse current.

In 1893, the opponents of alternating current had themselves joined its advocates.

CALLING CARDS

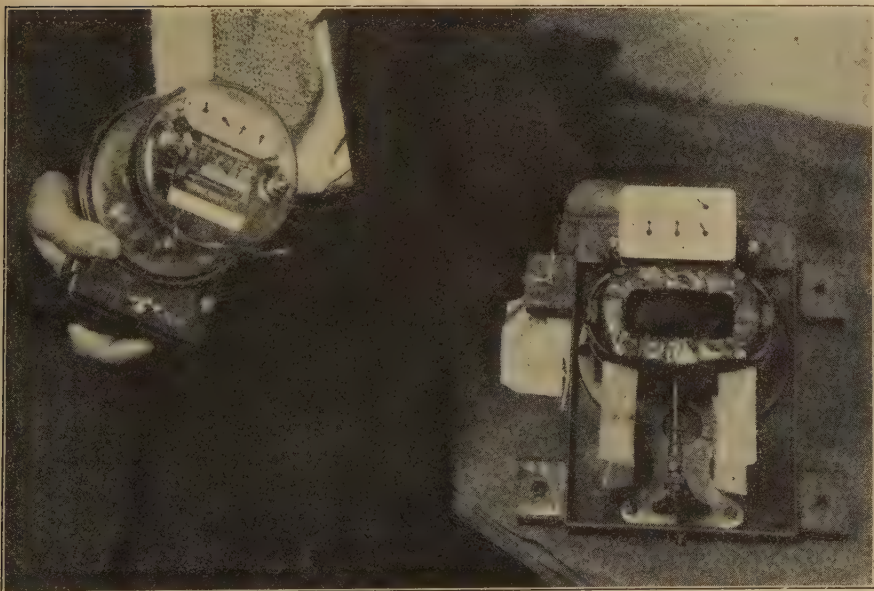
Even in China the custom of asking Father was in vogue. Would-be Chinese sons-in-law engraved their names and bits of family history on brilliant red cards and presented them to their prospective

father-in-law as an indication of their desire to marry into the family. Gradually these cards came into use for social purposes and thus calling cards had their inception.—*N. Y. World*.

ORIGINAL WATTHOUR METER

The question of a meter to measure the customer's energy bill was unsolved when the A. C. system was launched, in 1885. Even direct current service could be measured only very clumsily and expensively. A young Westinghouse Engineer, Shallenberger, aged 28, observing loose spring near an A. C. arc lamp revolving mysteriously, said "There's a meter in that!" and in less than a month had completed the meter. The generator type and principles have been found in all A. C. watthour

meters ever since, to this day, being universally copied when the patents expired. The induction meter is not merely the only one for A. C., but is also cheaper, more reliable, and less in need of attention than the meter used for D. C. The original form which measured only ampere hours (theoretically sufficient for a lighting load at constant potential) was very widely used. Some are known to have been in service at least until 1915. In 1894 the meter was modified into a true watthour meter.



THE FIRST AND THE LATEST WESTINGHOUSE METER

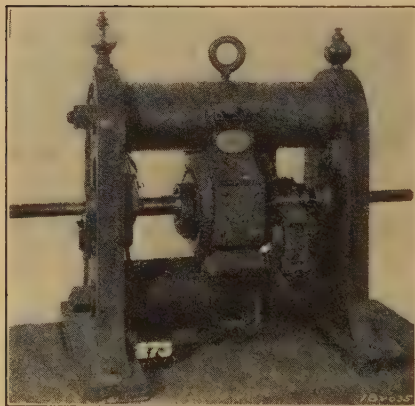
GRAMME DYNAMO

This dynamo was made by the British Electric Co. about 1870.

The shaft is in the plane of the magnetic circuit, and bearings in the yoke. Exact date unknown, but a very early

type. Similar machines were used in Germany before 1882.

Edison did his early experimental work with a machine of this type.



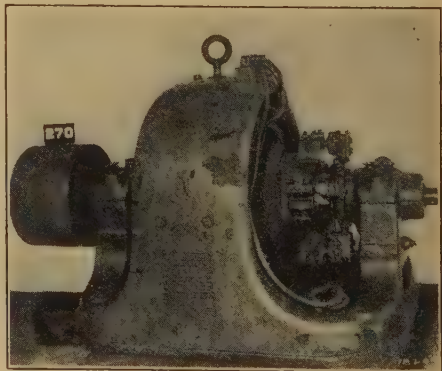
GRAMME DYNAMO



THE FIRST WESTINGHOUSE TRANSFORMER

MULTIPOLAR DYNAMO

This was an epoch-making machine, the first distinctively Westinghouse type, the work of Albert Schmid. A chart of 1889 showing 24 different field forms in use, mentioned Westinghouse as the only user of the form which is now universal—a multi-polar ring with inwardly-projecting poles, each with its field coil. This form, originated for alternators, was by Schmid first applied to direct current dynamos. It was universally imitated and drove all bipolars from the field.

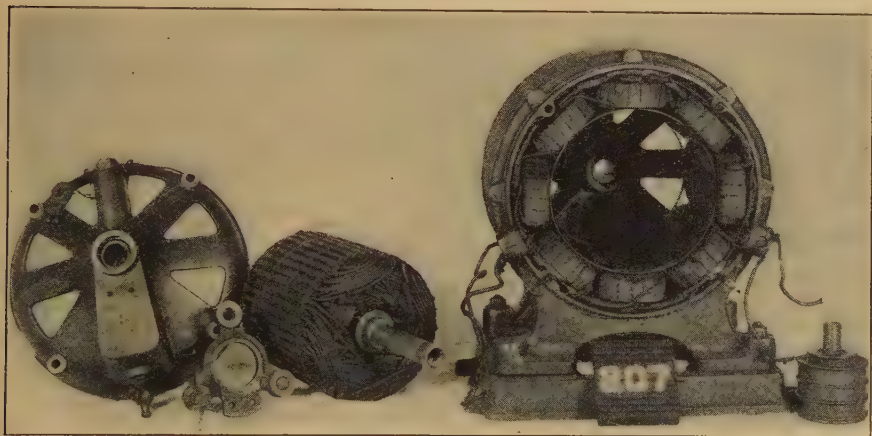


MULTIPOLAR DYNAMO

A. C. MOTORS

Lighting was the principal objects of the central station business, and when alternating current was first brought out, it succeeded despite the absence of any satisfactory A. C. motors. The need for these rapidly developed. Tesla in 1888 had patented his idea of the polyphase induction motor, other Westinghouse engineers were hard at work reducing the ideas to practice, many experimental models were built,

In that year appeared the type "C," an epoch-making motor. This was fundamentally a modern-type motor, electrically or mechanically, and definitely established the induction motor as the general standard for nearly every purpose, and did more to forward motor-drive generally than any other line of apparatus ever built. Its virtues caused the adoption of alternating current in many shops and plants where as



TESLA MOTOR OF WESTINGHOUSE ELECTRIC AND MFG. CO.

and by 1890 a number had been put in service.

It was necessary to the success of the Early experimental motor that central stations be converted to synchronous motor, polyphase operation—a campaign to this end was waged beginning about 1891, and meanwhile the motor was greatly improved, the original polar windings being abandoned. About 1893 the first really commercial machine went on the market, the "Type B," which bore a family resemblance to the "MP" line. These were built up to 300 H. P. Above 5 H. P. the primary was the rotor,—just opposite to the present arrangement. A switch on the stator short circuited a starting resistance. The type "B" was widely sold up to 1897.

far as voltage goes direct current would have been satisfactory. It may be said to have definitely destroyed the 500 volt D. C. power circuits formerly maintained in many cities.

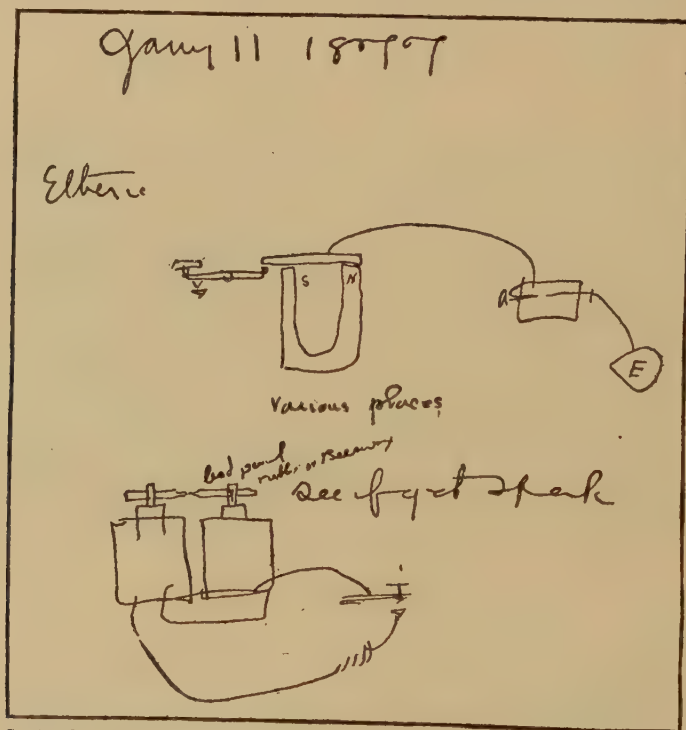
Many variants of the "C" appeared, all recognizably of the same family, including wound rotor, and other types. The largest induction motors in the world in 1904 were three 2000 H. P., type "C" which operated the Cascades (St. Louis Exposition). One, rewound as a synchronous motor, is still running daily in the East Pittsburgh power house, 24 years later.

The first American polyphase locomotives were the 160 H. P., tonnage engines of the Miami and Erie Canal, in 1902.

EDISON'S RADIO EXPERIMENTS

When Guglielmo Marconi, speaking recently from London to the National Electric Light Association in convention in San Francisco and to the World Power Conference in Berlin, paid tribute to Thomas A. Edison, few who listened in on this most elaborate broadcast in his-

radio more than half a century ago is brought out in a series of forgotten notebooks that have just come to light again in a box of old papers in his laboratory at Orange, N. J. These contain the only record yet found in his own hand of his experiments with what he recognized as a



Courtesy N. Y. Times

EDISON'S FIRST NOTE ON WIRELESS TRANSMISSION

tory knew that the power that enabled scientists to exchange greetings from the four quarters of the globe was a subject of experiments by Edison as far back as 1875 and was called by him "etheric force." Still fewer, probably, had heard that he sold the only patent he ever took out on wireless to Marconi's company in 1903.

How far in advance of the thought of his time Edison was when he anticipated

"strange, new force," twelve years before the work of Hertz and twenty years before Marconi's.

"I shall personally never forget," said Senator Marconi in his recent address, "the encouragement and the friendship Mr. Edison so generously gave me in the early days of my work." Not only was the inventor a friend of the gifted Marconi during the company's struggling years, but he even refused to sell the pat-

ent to a rival concern. Always he has given the highest praise to Marconi for making radio possible.

EDISON'S WIRELESS

The principle behind Edison's wireless patent was that of induction. The apparatus was to provide a system of transmitting signals electrically to be used between ships at sea, between ships and the land, and between distant points on land. While not the same, it contained many of the elements of wireless. It had elevated masts carrying condenser surfaces to spread electrical impulses, what is very like antennae on the masts of ships, and a detecting apparatus. If he had thought of applying his discovery of "etheric force" to this invention, he would have had wireless. It was within his grasp.

When he announced his experiments with "etheric force," many scientists jeered. As for laymen, in the '70s there was no popularization of science books. The generation that Currier & Ives and Godey's Lady's Book did so much to commemorate was absorbed in headlines on the Tichborne case, the escape of Boss Tweed, who had looted New York of \$20,000,000, and so on. In the large cities skyscrapers had not yet begun to mount, for there were no elevators, no incandescent electric light. There were no subways, no trolleys, no automobiles, no airplanes. This was before the day of the telephone.

Noting the tendency of the new phenomenon to diffuse itself through the air and through material bodies, Edison called it first "etheric" and then "etheric force." Hertz later named it "electric force." Edison also used such terms as "etherism," "ethericity" and "etherodes" to distinguish it from electricity as then understood. There is even a drawing by him in one of these old notebooks for a machine for "etherolysis."

In his experiments in 1875, of which the notes were kept by an assistant, Charles Batchelor, the inventor tried twenty-eight metals. Of these, iron and cadmium were the most satisfactory. He also tried with negative results more than fifty solutions of different substances to ascertain if the "force" would mark on paper with these solutions. The books just found record additional experiments with

solutions. They are dated at the "Menlo laboratory," while the earlier experiments were made at the Ward Street shop. Newark.

Aside from their scientific content these old notebooks are significant for the light they throw on the personality of the inventor. His characteristic disregard of day and night soon becomes apparent. "Quit work at 6 A. M.," reads an entry of Jan. 12, 1877.

Most unusual is his memorandum on Jan. 7, 1877. "Been sick last three days," it reads, "eyes very bad, couldn't do much." These eyes fifty-three years later still serve him through long hours of daily work.

Once he writes, "This page is a failure," and signed his name repeatedly as if in a moment of relaxation; the signature being witnessed by Batchelor, Adams and Johnson, assistants. The page ends with a favorite quotation written in his most perfect vertical hand, "Now is the winter of our discontent made glorious summer by this sun of York."

His comments on experiments run the scale from "Discovery," "Extra First Class," "Phenomenon," "Beautiful Experiment" to "Curious," "Unreliable," "Quite Stinking"—the solution, not the experiment, "Nix." Suggesting the democratic relationship between him and his staff is the inquiry from one of them: "Edison, what do you think if I make the rubber half as thick?"

THE APPARATUS

Any bright lad could duplicate today the apparatus that the inventor was using when he first noticed "etheric force." "A vibrator magnet," says the first notebook entry, "consisting of a bar of Stubb's steel fastened at one end and made to vibrate by means of a magnet." In the course of his experiment, the electromagnet and interrupter were connected to gas pipes and a dark box was set up in another part of the building. It contained two adjustable conducting points, lead pencils (graphite) close together. An eye piece made it possible to observe the length of sparks between them.

When Edison saw electric energy manifesting itself in open circuit, he did not know that this was due to electric waves in free space. He recognized, how-

ever, that he was dealing with a new power and maintained his view in the face of ridicule. The results brought out in these experiments were described in articles in *The Scientific American* and other contemporary journals.

In 1881 the inventor included "etheric force" in his exhibit at the Exposition Internationale d'Electricité at Paris. Here was shown the dark box of the Menlo Park experiments. This is now in possession of the New York Edison Company.

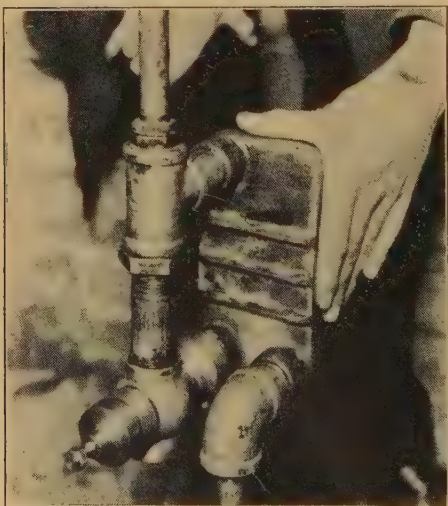
Paris might listen to lectures on "etheric force" and scientists, perhaps even Hertz, whose mathematical genius was to provide the basis for wireless transmission, hear them, but Edison worked in America

where money for experiments was the determining factor in what should be done next. And so when a group of financiers offered to back him if he would devote himself to developing a commercial incandescent lamp he concentrated upon this.

The spark that the inventor recognized as a "new force" now girdles the earth in a split second. It served Byrd at the bottom of the world and Kingsford-Smith battling Newfoundland fog. In the lengthening list of those who are revealing its mysteries, the name of Thomas A. Edison will always be remembered for the prophetic quality of the discovery recorded in these old notebooks of so long ago.—*Mary Childs Nerney in N. Y. Times.*

PREVENTS FROZEN WATER PIPES

A simple device, to be connected directly in a residence water supply system and which prevents freezing and bursting of pipes, has been invented by a South Carolinian.



PREVENTS FROZEN WATER PIPES

This device follows the thermometer and shuts off the household water supply when there is a threat of frozen and burst pipes. The principle is entirely new, and does not depend upon a thermostat or other mechanical device. Operation of the cut-off is automatic under natural laws. Returning warmth turns the water on again.

To accomplish this automatic operation, the device has a brass freezing chamber which spreads the water into a thin sheet easily frozen. The internal cavity of this chamber carries the exact volume of water that passes through the pipes. The flattened stream freezes at a temperature about 10 degrees higher than that which would freeze the water in the pipes themselves. Within the chamber, the ice takes the form of a wedge at inlet and outlet points. In freezing, the sheet of ice chokes the chamber and prevents the flow of water. The expanded ice exerts pressure against a metal diaphragm which opens a drain valve and empties the house pipes of all water. When the house becomes warmed, the thin sheet of ice thaws quickly and the thawing releases the pressure, closes the drain valve, and restores normal flow in the system.

PENTODE RADIO TUBES

In England and its colonies, and on the continent of Europe, the cost of radio broadcasting was formerly paid by the owner of receiving sets in the form of a burdensome tax levied according to the number of tubes used. Very recently this form of tax has been modified to include a small flat tax on the set and a reduced rate upon each tube.

The former method of taxation was effective in stimulating engineers to design sets having less tubes without loss of satisfactory reception. In order to compensate for the losses by the elimination of some of the tubes, tubes having a higher amplification gain per tube were designed and are now in common use in those countries. Chief among this class of tubes is a five element tube known as a pentode tube.

The pentode tube has one more grid than the screen grid tube. The extra grid is placed close to the plate and is at 30-50 volts lower potential than the plate itself. In this position it absorbs the secondary emissions from the plate and prevents the accumulation of a "fog" of electrons around the plate. The audible result of this fog is commonly called distortion.

WELL KNOWN IN EUROPE

For the past five years these tubes have been used in England and the continent in conjunction with magnetic type loud speakers giving high amplification and increased power output but with poor tone quality. The advent of the dynamic power speaker has stimulated a greater interest in the characteristics of this tube among

radio engineers in this country since, when used with the dynamic speaker, good tone quality is produced.

It is difficult at present to foresee just what effect this new tube will have upon the radio industry as a whole. It is probable that we shall have pentode tube receivers this year. It is entirely possible that radio sets consisting of one radio frequency pentode amplifier with one three element detector tube plus one pentode tube audio amplifier tube will replace the present six or seven tube A.C. sets. The saving on power will be small but there is a possibility that the cost of production of sets will be less since pentode tube receivers should require less internal equipment and hence will be smaller in dimensions. The present state of development, however, is such that the possible saving on the usual equipment is partly overcome by other additional equipment which at present is required with the pentode.

There are many opportunities to employ the pentode tube to advantage under crowded conditions or where the set is battery operated as in airplanes, automobiles and in other portable sets. There are, however, certain difficulties in the pentode tube construction which must be overcome before the tube will be satisfactory for other than home use.

The cost of tubes for a pentode equipped set will probably be nearly equivalent to the cost of the tubes for the present type A.C. receiver because the pentode is inherently a much more delicate quantity production problem.—*Industrial Bulletin, Arthur D. Little, Inc.*

GLIDER MAKES 12 LOOPS

Lyman Voelpel trebled the previous world's record for loops in a glider on May 9, 1930. Flying a two-passenger biplane glider, he made twelve consecutive loops above the Curtiss airport. The previous official record was four. The at-

tempt was made under a permit by the Department of Commerce.

Soon after Voelpel had established his record, Jimmy Van Cise made what he said was the first parachute jump from a glider.

SOUND FOCUS FOR MICROPHONE

An artificial "whispering gallery" is one of the latest improvements in talking movies, for the device makes it possible to focus the microphone on the speakers, and shut out extraneous sounds. Recording engineers of the RKO Productions here have developed the device, which is called the "beam microphone," and have been using it in a new production, "The Record Run."

The device is really a searchlight turned backwards and using sound instead of light. A searchlight reflector has the shape known as a paraboloid. Light radiating from a point known as the focus is reflected in a parallel beam. The reflector also works backwards. If a parallel beam of light, as from a very distant object, falls squarely on the reflector, the light is concentrated at the focus. Searchlight mirrors have actually been used this way with sunlight to obtain high temperatures for experimental purposes. A reflecting telescope used by astronomers works the same way.

Waves of sound can also be concentrated by a parabolic reflector, and this is the principle of the beam microphone. A metal reflector about five feet in diameter is used, with the usual condenser microphone placed in the center at the focus. Around the outer edge is a cylinder of felt to shut out most of the sound that would come across the edge of the reflector.

In use, the beam microphone is mounted in trunnions on a stand similar to those used for the large lights for illuminating the studio. It can be aimed at the actors, whose voices are picked up and intensi-

fied, while other sounds, if not too loud, are largely eliminated.

Though the device has proved especially valuable for out-of-door recording, where it is not always easy to prevent other noises in the neighborhood, it is also being used to advantage within the soundproof studios. For instance, the RKO studios are now producing some pictures in wide film as well as the normal 35 millimeter version. The wide film cameras are much noisier than the ordinary ones, and more difficult to silence with a soundproof cover, or "blimp." The beam microphone aids in keeping their grinding from recording along with the voices of the actors.

Famous whispering galleries, in buildings throughout the world, depend on a similar principle of sound concentration. Some architectural freak may produce a curved wall that focusses the sound from a distant point. Then a person may hear a whisper from a position hundreds of feet away, but cannot hear ordinary conversation much closer.

In the Louvre, in Paris, there is a famous whispering gallery caused by two huge alabaster bowls at opposite ends of a long chamber. A person standing before one bowl can hear a whisper made by a person at the far side of the other one. The bowl acts as a reflector, sends the sound waves in a beam to the curved ceiling, whence they are reflected to the other bowl, which then, like the microphone reflector, focusses the sound so the second person can hear it.—*Science Service.*

TELEPHONE PROGRESS, 1929

The year 1929 has been one of distinct progress in the improvement and extent of communication by telephone. About 900,000 telephones—the largest number in any year—were added. Approximately 1,600,000,000 more local telephone calls and 100,000,000 more toll and long-distance calls were handled than in the previous year. At the same time, the quality and speed of service were not only maintained but definitely improved.

To provide for growth and to improve service, \$588,000,000 was spent on construction of new telephone plant and \$45,000,000 on construction of new manufacturing facilities. These expenditures for additions, betterments and replacements were the largest in any one year and furnish a basis for still further progress. It is expected that the expenditures for construction in 1930 will be over \$700,000,000 as compared with the 1929 total of \$633,000,000.

The use of the telephone in the United States is so universal that it exceeds that of any other country in the world. With the development of the telephone art it became possible a few years ago for the telephone users in the United States to communicate with those in Europe and other parts of the world. Extensions of such international communication to additional countries were made during 1929 and a new service of telephone communication between shore and ships at sea was inaugurated.

At the end of the year there were more than 20,000,000 telephones interconnected in and with the Bell System in the United States. Approximately 4,400,000 of these were telephones of independent connecting companies—about 7,700 different companies and 30,000 rural lines. Practically any one of these 20,000,000 telephones can be connected promptly, not only with any other telephone in the United States but with 9,000,000 telephones in Canada, Cuba, Mexico and Europe.

The rapid growth in the business during 1929 necessitated large additions to the forces, and the total number of employees at the end of the year, including those of the Western Electric Company, Incorporated, was 454,000 as compared

with 395,000 December 31, 1928, an increase of 59,000—comprised of 39,000 men and 20,000 women. To provide for this growth and to take care of normal turnover, it was necessary to train more than 175,000 new employees.

SERVICE IMPROVEMENTS

During the past five years the average time required for completing a long-distance connection has been cut more than in half, the average speed of long-distance connection being reduced from 7.5 minutes to 2.4 minutes. The errors in local calls, which were only two in 100 calls, have been substantially reduced. The quality of transmission has been improved. The proportion of customers' orders currently subject to delay because of lack of facilities and equipment has been reduced from 10 per cent to 2 per cent. The average elapsed time between receipt of a customer's order and installation of service has been reduced from 4.7 days to 2.7 days. The system of installing telephones on definite dates set by the customer has been greatly extended and where it is in effect, in 96 per cent of the cases during the past year the customers' wishes were met.

Five years ago on an average there was trouble on a subscriber's line once in every 13 months as compared with trouble only once in every 20 months now. Today 87 per cent of the troubles are corrected on the day reported.

It was formerly necessary on practically all long-distance calls for the subscriber to hang up the telephone after putting in the call and to be recalled when the connection was ready. In 1925 operating methods were developed which made it possible to handle long-distance calls with speed approaching that of local calls. In 1929 more than 70 per cent of the long-distance calls were handled while the calling subscriber remained at the telephone.

The mere publishing of telephone numbers is a large undertaking in itself. In 1929 there were 18,000,000 listings and 35,000,000 directories were issued. Steady improvement is being effected in the appearance, ease of reference and accuracy of telephone directories.

RATES

Beginning in the latter part of 1926 there has been a series of reductions in long-distance rates amounting to a saving of many millions of dollars a year to telephone users. A telephone call from New York to San Francisco, which a little over three years ago cost \$16.50, now costs \$9.00, and corresponding reductions for lesser distances have been made. For instance, a telephone call from New York to Chicago, which formerly cost \$4.65, now costs \$3.00.

Within a year two of these reductions in long-distance rates were made effective—February 1, 1929, and January 1, 1930—each of them resulting in a saving to the telephone users of approximately \$5,000,000 annually.

SERVICE EXTENSIONS

Besides the 900,000 telephones added to the Bell System in 1929 in the continental United States, there was added by extension of the service access to 340,000 telephones in Italy, Ireland, Gibraltar, Luxemburg, Isle of Man and portions of Austria and Czechoslovakia. Including the telephones added in this country and those added in countries with which telephone communication is established, the telephone user in the United States could, at the end of the year, communicate with 1,670,000 more telephones than at the end of the previous year.

During the year two additional short-wave transatlantic radio telephone channels were put in operation. The transatlantic telephone service is now being furnished over one long-wave and three short-wave radio telephone channels. Work is going forward on the new transatlantic telephone cable which will supplement the present radio channels and add a connecting link that is not subject to the inherent uncertainties of radio. Early in 1930 it is expected to inaugurate telephone service by short-wave radio with the Argentine, and plans are under way for the establishment of a short-wave telephone station on the Pacific Coast for radio telephone communication with Hawaii and other points in the Pacific.

In December, ship-to-shore service was inaugurated to and from the steamship *Leviathan* and it is expected that in due course this service will be extended to other steamships.

Marked progress has been made during the year in the development of telephone communication with airplanes. A large number of trials and demonstrations have shown that satisfactory two-way telephony is possible between airplanes and any telephone connected in or with the Bell System. In several of the tests commercially satisfactory communication was maintained between an airplane here and telephone stations in Europe. This involved radio transmission from the airplane to the Bell telephone wire system in the United States, the transatlantic radio and the regular telephone wire system in Europe. The successful demonstrations of our development of two-way plane-to-ground telephony have caused several of the larger air transport companies and several of the Government departments to request us to equip a considerable number of planes and ground stations with apparatus. This equipment of airplanes with telephones for navigational purposes will add greatly to the safety and efficiency of transportation by air. Ultimately it is expected that telephone service will be established between airplanes and any telephone anywhere that is connected with the Bell System.

Over 4,000,000 Bell-owned telephones, or 26 per cent, are now on a dial basis and it is expected that by 1934 the proportion will be close to 60 per cent. About 74 per cent of the toll wire mileage is now in cable as compared with 53 per cent five years ago.

The striking increase in the use of the telephone for long-distance calls, so noticeable in 1928, has continued during the past year, reflecting the public's response to the steadily increasing speed and quality of service and the reductions in charges for the service. While the use of long-distance has been increasing so rapidly, the telephone user, stimulated in part by the telephone companies' efforts, is equipping his office and particularly his residence with more telephones, with a view to greater convenience and utility.

DEVELOPMENT AND RESEARCH

During the year there has been a considerable increase in the size of the group engaged on research and development problems designed to produce new and improved equipment and systems for telephony and telegraphy. At the present time

there are in the Department of Development and Research of the American Telephone and Telegraph Company, and in Bell Telephone Laboratories, Incorporated, more than 5,400 scientists, engineers and assistants engaged on this work.

The results of the work of this group during 1929 have emphasized again both the wisdom and the necessity of adequate expenditures for fundamental research and development if our policy of enlarged and improved service at minimum cost to the user is to be maintained.

The fundamental physical conditions which underlie efficient telephone and telegraph operation are such that large expansion either in volume of service given or in range of distance covered cannot be made economically—frequently cannot be made at all—merely by an enlarged use of existing instrumentalities.

WESTERN ELECTRIC COMPANY, INCORPORATED

The requirements of the Bell System for equipment increased very substantially during 1929 over the previous year and greatly exceeded the capacity of the Western Electric Company's manufacturing plants. This situation was met by temporarily expanding facilities through the rental of outside quarters; and this expansion, combined with the rapid upbuilding of the force and the utilization of overtime and night work on a large scale, enabled the company to increase its production by 67 per cent over that of 1928. Total sales for the year amounted to \$411,000,000, the largest in the company's history, and during the year the number of employees increased from 56,324 to 84,848.

At the same time provision was made for the permanent expansion of Western Electric manufacturing facilities, involving large additions to the Hawthorne and Kearny plants, and the starting of a third plant at Point Breeze, Baltimore, Maryland, where a tract of 180 acres was purchased early in 1929. Construction was started in the spring on the Point Breeze Works to provide initial facilities for making cable, insulated wire, and telephone apparatus; and the first cable was produced on the last day of the year.

At the beginning of 1929 the company's Hawthorne and Kearny Works had a

combined floor area of 5,160,000 square feet, and during the year the additions made at these plants, together with the new construction at Point Breeze, increased this area to 6,520,000 square feet. In 1930 this will be further increased to 9,190,000 square feet. This expansion program, started early in 1929 and scheduled for completion about midyear, 1931, involves an expenditure of \$110,000,000. When the three plants are fully developed to capacity they will be about equal in size, with an aggregate floor area of 15,000,000 square feet, and will employ on a normal operating basis 110,000 people.

Although the heavy demands of the Bell System for Western Electric products necessitated intense effort being applied to increasing production throughout the year, there was no slackening of effort to reduce costs, and prices were reduced to the extent of \$11,250,000 for the 1929 volume of output.

ELECTRICAL RESEARCH PRODUCTS, INCORPORATED

Reference was made in last year's report to the formation of Electrical Research Products, Incorporated, as a wholly-owned subsidiary of the Western Electric Company, for the purpose of making commercially available the developments and inventions of the Bell Telephone Laboratories applicable outside the telephone field.

The most noteworthy of these developments has been the talking motion picture, a new form of entertainment which has taken hold of the imagination of the American public and is now rapidly spreading throughout the world.

The Western Electric recording system is being used, under licenses granted by Electrical Research Products, by the majority of the motion picture producers; it is installed in about 70 studios and used for the production of about 90 per cent of the talking pictures being made today. Reproducing apparatus has been installed in 3,300 theatres in the United States and in 1,100 theatres abroad. These installations are inspected and maintained by Electrical Research Products, in order that there may be continuity and reliability of operation.

Also the progress of electrical science as illustrated by the modern high-speed

submarine telegraph cables and the recording and reproduction of sound for use in connection with phonographs has been forwarded. The business of Electrical Research Products is limited to making arrangements for the commercial use of these developments by concerns operating in the fields in which they are applicable. The American Telephone and Telegraph Company neither directly nor indirectly, through Electrical Research Products or otherwise, owns any stock in any motion picture enterprise or any other commercial undertaking operating in these fields.

FINANCIAL

In 1929 the Bell System revenues from local exchange service increased \$47,000,000, or 7.3 per cent over the previous year, and revenues from toll and long-distance service increased \$45,000,000, or 14.5 per cent. The increase in total operating revenues was \$95,000,000, or 9.8 per cent. Due in part to additional expenditures for better service, the total expenses increased 11 per cent and investment in plant and other assets increased 10.5 per cent. The total plant and other assets at the end of the year amounted to \$4,228,000,000. The net earnings for the year were at the rate of 6.8 per cent on the cost of plant and other assets.

On April 30, 1929, the American Telephone and Telegraph Company offered to its stockholders an issue of Ten-Year Convertible 4½% Gold Debenture Bonds dated July 1, 1929. Stockholders of record on May 10, 1929, were entitled to sub-

scribe for \$100 principal amount of these convertible bonds for each six shares of stock then held. Subscriptions for \$218,007,200 were received out of a possible total subscription of \$219,112,700.

As of July 1, 1929, the Company retired an issue of \$78,000,000 of Collateral Trust 4% Bonds then due.

In January, 1930, the American Telephone and Telegraph Company sold an issue of \$150,000,000 Thirty-Five Year 5% Gold Debentures, dated February 1, 1930. This issue of debentures will provide in part the funds required by the Bell System for additions and betterments and other capital expenditures during 1930. After giving effect to this issue of debentures the Company's long-term debt as of February 1, 1930, was less than \$644,000,000, or only 31 per cent of its total capital liabilities, and but little more than 24 per cent of the book value of its total assets.

These issues followed an offer of stock to the stockholders of \$185,000,000 made in 1928 on which the final payment was received in April, 1929.

The number of stockholders of the Company increased from 454,596 at the end of 1928 to 469,801 at the end of 1929. The average number of shares held per stockholder is now 28. No single individual holds as much as one per cent of the total capital stock. Of the total number of stockholders about 90,000 are Bell System employees.

WALTER S. GIFFORD,
*Annual Report of American Telephone
and Telegraph Co.*

INDIAN CHIEF RADIO ANNOUNCER

The first radio announcer in the world to be appointed chief of an Indian tribe is George Wright of CNRV, the Vancouver broadcasting station of the Canadian National Railways. Wright has been made chief of the Squamish Indians and given the title Chief Sa-Sayqo-Sa-Nay-Chim which, translated, means Chief Flying Voice.

The honor was conferred upon Wright for his assistance in calling to the dying chief of the tribe, a daughter who was some hundreds of miles away in the wilds

of British Columbia. The last request of the chief was that his daughter should be brought to see him. Every endeavor to locate her through telegraph, the Royal Canadian Mounted Police and other government agencies, proved fruitless. In a final effort the Indians appealed to Wright and he broadcast a special message to the girl. It was picked up by a lonely trading station where the girl was located and she was put on board a boat to arrive home just before her father died.

UNDERGROUND TELEPHONE CABLE

NEW YORK TO ALBANY

The New York Telephone Company's underground route between New York and Albany is already in service. Although the telephone subway will not be finished for two years, the parts of it which are ready contain a part-underground cable which was put into service early in June.

The largest link between Albany and New York provides for from 212 to 340 circuits, thus increasing by about 50 per cent. the combined capacity of the other four cables, all of which are overhead.

The subway work was begun about a year ago and is about two-thirds completed. It is to be 150 miles long. So far the excavations along the west side of the Hudson River have covered sixty-three miles from New York City through northern New Jersey to Monroe, N. Y., and thirty-two miles from Albany to Catskill.

TO BE COMPLETED IN 1932

Work on the remaining section is expected to be in progress until some time in 1932.

When this subway is completed company engineers expect it will be adequate for the needs of the service for some years. It will have room for from ten to thirty ducts through which more than 3,000 miles of cable can be drawn. It is the company's plan to extend the subway further to the north and west as the State's telephone requirements grow. This contemplated expansion would eventually provide links in a nationwide system of telephone connection beneath the ground.

Not all of the lines from New York in the new part-buried cable terminate in Albany. Many of them are through circuits to other parts of the country, and during the next five years more long distance cables are likely to be run through the subway ducts. Underground long

distance cable in the nation-wide Bell system is increasing at the rate of about 20 per cent. a year, and in New York alone the telephone company has added about 160,000 miles of wire to such circuits in three years.

The New York-Albany cable is the second longest of its kind in this country.

It will take care of a service which in the last three years has increased by almost 50 per cent. and which up to the installation of the latest cable was nearly at capacity.

UNDERGROUND CABLES IMPROVED

The construction of the subway from here to the capital is part of a program in which all the Bell companies are taking part.

In the early days of the telephone it became evident that the overhead wires would prove too cumbersome to be continued as demands on the service grew and efforts were made then to bury them. Placed underground for any considerable distance, however, they would not in that stage of the telephone's development give proper service.

Various technical improvements were made, as a result of which first the wires for urban service went beneath the street surface, and now the wires on longer circuits are being buried.

The first long distance underground cable was only ten miles in length and was laid between New York and Newark in 1902.

The longest cable in the country, which will not be surpassed by the lines in the subway now under construction, was completed in 1913 and connects Boston and Washington. It is 450 miles long.

—*New York Sun.*

INDUSTRIAL MAGNESIUM

Magnesium's history is in some ways similar to aluminum. It has long been known but has only recently become a member of the family of industrial metals. This year is the hundredth anniversary of the preparation of magnesium metal, and the history of its compounds goes back even further, for Epsom salts or magnesium sulfate was discovered in the water of the springs at Epsom, England, in 1695. The medicinal value of these waters led to the discovery of the salt possessing these properties.

In 1852 Bunsen obtained magnesium metal by electrolyzing the fused chloride and this is still the basis for its manufacture.

When magnesium metal was first made, electric power was not available in quantity and at a low price. Today, the development of electrical engineering has enabled us to obtain unlimited electric power at a low cost. Commercial metallic magnesium could only be produced by cheap and abundant electric power.

The innumerable details of commercial manufacturing of magnesium have been developed by the research department of the Dow Chemical Company and the cost of the metal has fallen from \$5.00 a pound in 1915 to 57 cents in 1929. Today the purity of the metal from the cells is 99.9% and sometimes reaches 99.95%. The decrease in price has caused an increase in consumption from 50,000 pounds in 1921 to an estimated 900,000 pounds in 1929.

Magnesium is extremely abundant. The relative amounts of some of the commoner engineering metals in the earth's crust are as follows:

Aluminum	800
Iron	500
Magnesium	200
Nickel	3
Copper	1

It is therefore evident that the supply of magnesium is almost unlimited. All of this is in the form of compounds. There are many compounds of magnesium known, but only magnesium chloride can, at present, be considered as a magnesium ore. Fortunately, this is one of the most abundant of magnesium compounds.

The Michigan salt brines contain large amounts of magnesium chloride. These brines come from wells about 1200 to 1400 feet deep and contain about 3% magnesium chloride along with other salts. Magnesium chloride differs from the ores of all other engineering metals in being water soluble and in being obtained as an aqueous solution. Its properties are very similar to common salt.

The first step in manufacturing magnesium is a complex fractional crystallization to separate a pure magnesium chloride from all other salts. The next step is removing the water. Heating in hydrochloric acid gas, developed by the Dow Company, prevents the decomposition that would otherwise take place on heating, and makes magnesium metal possible. The dry magnesium chloride is melted and electrolyzed to give the metal, which floats on the bath of fused salts.

There are four main uses of magnesium metal and many smaller ones. When magnesium metal burns an intense white light is given out. This is the basis for the use of magnesium in flashlight powder, fireworks, and illumination bombs, a use that has caused many to consider magnesium combustible. However, it is combustible only when powdered or in the form of wire or ribbon. Massive forms are no more combustible than other engineering metals; aluminum, iron or even lead burns readily under certain conditions.

The second use is in organic syntheses, where magnesium makes possible the preparation of many substances otherwise difficult or impossible to produce.

The third use is as a deoxidant in metallurgy, particularly in the nickel and nickel alloy industry.

The above uses are special and more or less independent of the metallic nature of the element. The fourth use is as an engineering metal. Magnesium is mainly used in engineering in the form of its alloys, particularly the Dowmetal. These are the lightest structural metals available for engineering purposes; for example, if we take the weight of a unit volume of Dowmetal as 1, aluminum would be 1.6 and steel 4.4.

When we compare the tensile strength

of bars of equal cross section of steel and Dowmetal, we have: mild steel 60 as compared with Dowmetal 42. With bars of equal weight we have mild steel 60 against wrought Dowmetal 185. That is, on an area basis it is about $\frac{2}{3}$ as strong as steel, but on a weight basis it is three times as strong.

The metal may be cast, forged or extruded, and is easily welded and machined. Scrap may be recovered by melting in flux and the recovered metal is identical with new metal, since the flux removes all impurities.

Dowmetal is as resistant to atmospheric corrosion as any engineering metals and is less easily corroded than steel. Its strength does not decrease with age due to absence of intercrystalline corrosion and season cracking.

Today we may say that magnesium in the form of its alloys has definitely made a place for itself in the family of engineering metals. In spite of the youth of this industry it has proved its value and its importance should constantly increase. —*Industrial Bulletin*, Arthur D. Little, Inc.

SYNTHETIC RESIN IMPROVES LACQUER

Pyroxylin lacquers, to which we owe the lastingly beautiful finish of our automobiles, furniture, and hundreds of other common objects, are basically nitrocellulose, or gun cotton. This very useful product has one disadvantage for this purpose, however, for the film formed upon drying normally lacks luster and adhesion. This has been overcome in modern lacquer production by the addition of resins to the lacquer.

Unfortunately, the materials which are the best solvents for nitrocellulose are the poorest solvents for these resins, and vice versa. With some resins it is very difficult to get a homogeneous solution containing both nitrocellulose and resin, and practically impossible to get a homogeneous film. With any natural resin the lacquer formulator must balance his resin and lacquer solvents very skilfully, and he is constantly confronted with the difficulty that he has, as an ingredient, a material which in many respects is incompatible with nitrocellulose.

Alan C. Johnston, of the Hercules Powder Company, describes in a recent issue of *Industrial and Engineering Chemistry*,

a new synthetic resin which appears to be ideally adapted for use in lacquers because it is soluble in nitrocellulose solvents. This latest contribution of synthetic chemistry to lacquer technology is ethyl abietate. Until recently this compound was regarded as a laboratory curiosity, but is now available commercially.

Commercial ethyl abietate has a very slight but agreeable odor. In lacquers the odor is not apparent. Sunlight does not discolor the material itself. When used in a lacquer containing zinc oxide and nitrocellulose, the film does not discolor any more than does a lacquer containing zinc oxide, nitrocellulose, dibutyl phthalate, and dammar gum, both films discoloring to a considerably less extent than films containing zinc oxide, nitrocellulose, dibutyl phthalate, and ester gum.

In ethyl abietate a natural resin has been changed in chemical composition in such a way that, while it still retains its primary resin characteristics and imparts to the film gloss, depth, body, and adhesion, as a resin should, it has ceased to be incompatible with nitrocellulose and has come to have actually a latent solvent action on nitrocellulose.

RUBBER LATEX

The best rubber of the past came from the wild *Hevea brasiliensis* trees of the Amazon region. The descendants of the best strains of these trees make up most of the plantations of the Eastern tropics. Rubber is obtained from these trees in the form of a milk-like fluid called latex. In contrast to this latex method of obtaining rubber, that from the guayule shrub of the Southwest, is secured as worm-like masses of solid rubber, after maceration and washing away of the fibrous part of the plant.

Latex is not the sap of the rubber tree, but a liquid produced and stored in small quantities in the inner bark. On the first tapping, only a little exudes from each tree, but as the process is repeated, the yield becomes greater and greater for a number of days. The principal function of the latex appears to be as a natural protection against injury; when insects attack the tree, they are soon entrapped in the fluid, and the wound is sealed over as the fluid dries. Tapping may be kept up for long periods of time without serious injury to the tree, provided occasional recuperative periods are allowed.

Latex from the average tree contains about 33% of solid matter, but occasional trees are to be found which yield much richer latex, even up to 55% solid matter. The solid matter is roughly 90% of actual rubber, with the remainder principally resin, protein and sugar. The rubber is present as minute particles suspended as an emulsion in the watery fluid. The individual particles are very small, and many of them are tear-shaped. It has been found possible, under the microscope, to puncture these particles with a fine-pointed glass needle, and the particles appear to have soft gummy interiors and tough coatings. Chemical methods indicate a coating of protein matter around the rubber mass, but this is too transparent to show under the microscope.

The wild Para rubber was concentrated by evaporation over nutshell fires. A stick was dipped into the latex and the wet part dried. This was repeated until great "hams" of rubber were collected. When plantation rubber was started, acid coagulation of the

latex came into vogue, often followed by smoking and this resulted in the familiar pale crepe and smoked sheet forms, respectively. Recently, spray-drying of the latex has been introduced. This process is analogous to the one used in making powdered milk and gives an ivory-colored rubber which has excellent strength and keeping qualities, but rather low water resistance. Recently, it has been claimed to be possible to ferment the latex before spraying it, resulting in degenerated protein, and making a rubber which is soft and easily milled, like the acid-cured product. It is possible to mix latex with sulfur and other chemicals before spray-drying, resulting in a complete compound, which is ready for vulcanizing after compression and shaping.

SHIPPED IN LIQUID FORM

Latex arrives on the American market for the most part as the 33%, ammonia-preserved, liquid type, in tank-steamer loads. Some richer natural latex also arrives in drums, and a stabilized, artificially-concentrated paste form of 70 to 75% solid matter in hardwood barrels. Doubtless, before long, the 60% centrifuge-concentrated form will be the usual one, resulting in lower prices for the rubber by saving in shipping cost, and also being of advantage in having less water to be evaporated to obtain the rubber.

After the incorporation into latex of various materials to modify the viscosity, color, body, stability and texture of the resulting film, latex appears in numerous preparations such as can-sealing compounds, cloth and leather cements, and specialties such as compositions for making rugs non-slip on polished floors. Compounded latex is also "cast" into inner tubes and other forms, using plaster molds.

VULCANIZED LATEX

The particles of rubber in the latex can be vulcanized in the emulsion without visible alteration of the original milk-like character. This vulcanized product on simple evaporation makes films of vulcanized rubber which are resistant to solvents, and

highly resistant to aging and heat. Surgeons' gloves made from this material are of extraordinary strength and can be made of non-slip texture and are said to resist fifteen or more sterilizations in steam or boiling water. Strong artificial leathers can be made with its aid, and pile fabric such as automobile upholstery is now made with a backing of this rubber which holds the individual pile fibres.

Latex, plain or vulcanized, evaporates to leave a film which is similar in general properties to the film deposited by rubber cement on evaporation. Only water is evaporated, no expensive solvents used and no toxic or inflammable vapors are evolved. On the other hand, water tends to evaporate slowly and considerable heat is required to drive it off, denying the use of latex to those industries where these limitations are vital. Moreover, latex films do not adhere to vulcanized rubber, so that rubber cements must still be made with organic solvents.

"SHIPS AND SHOES AND SEALING WAX"

The number of advantageous applications of latex is continually increasing.

From time to time, we hear of entirely new uses for it, such as filtering sheets, brake linings, shoe soles, waterproof papers, and extremely strong papers and leatherlike compositions.

Perhaps the greatest intrinsic advantage of latex, plain or vulcanized, over bulk rubber is in the simplicity and low cost of the machinery needed for its utilization. The early rubber workers were unsuccessful in preserving and bringing latex in commercial quantity to their Northern locations. This necessitated basing the early rubber industry upon coagulated rubber. Present rubber working machinery is heavy and expensive and consumes large amounts of power. A prominent rubber technologist is authority for the statement that if latex had been available in the temperate zone from the start of the industry much of this machinery might never have been developed. The cost of latex is still relatively high, but it is expected that the price will gradually be brought down to where it will be economical for large uses which are now out of range.—*Industrial Bulletin*, Arthur D. Little, Inc.

NEW RUBBER BLOCKS X-RAYS

Radio fans who happen to be located near a hospital or any other place where an X-ray machine is operated, are painfully aware of the ease with which X-rays penetrate ordinary walls. In order to insulate an X-ray apparatus, it has been necessary to line the walls of the room with heavy sheet lead. Now, however, rubber chemists have discovered that certain lead compounds can be incorporated with rubber to make an ideal shield for the vagrant X-rays. The new material is known as Ray Rubber and has been successfully tried out in a hospital in New York City.

Ray Rubber contains a homogeneous lead compound which has passed all tests made by X-ray machine manufacturers. Dangerous X rays cannot penetrate Ray Rubber. It provides a good-looking surface easily kept clean, making the X-ray room attractive rather than dull and drab since the material is available in a variety of standard colors.

Ray Rubber replaces the old Holland barium brick, heavy and expensive because it had to be imported; barium mixed with plaster which cracked, permitting the rays to pass through; and lead, which requires expensive burners to perfect its joints. Ray Rubber has a peculiarly fashioned reverse curve edge which permits a small lap joint through which no X-rays can pass.

It is easily applied with an approved type of cement to walls and floors, doing away with troublesome fastenings of various sorts. For the floors it may be applied either to concrete or wood. Edges of the flooring and joints are made impervious to ray penetration by application of Ray-proof cement.

Ray Rubber is made in blocks 18 by 24 inches and 0.5 inch thick, which has an equivalent screening power against X-rays of 0.125 inch of lead.

SOFTENERS IN RUBBER

Much has been said about the remarkable progress revealed by the quality of present day rubber goods. Only ten years ago the best tires were not expected to give over 5000 miles of service. Today, a much lower priced tire is expected to furnish three times that mileage. The reasons for this have been given not only in the professional but even in the daily press. The toughening effects of carbon black have been mentioned; the use of organic accelerators which not only reduce the time of cure but also impart greater tensile strengths to the rubber has been explained, as was the use of anti-oxidants which prolong the life of the stronger and tougher rubber.

However, these improvements would be little better than laboratory achievements if it were not for the use of another class of organic substances. It is safe to say that the incorporation of carbon black and other reinforcing pigments, or that of the better grades of organic accelerators, could not have reached the present status without the accompanying incorporation of what the rubber industry calls "softeners." Toughening the rubber by compounding makes the rubber harder to manipulate and sensitive to the temperatures developed in the mixing and processing of rubber compounds. The "softeners" therefore acquire a practical importance by permitting these operations to take place under controllable conditions.

"Softeners" are not new ingredients in the rubber art. They have long been used for various purposes. But this use, in common with that of other rubber compounding ingredients, has depended upon the whims of the compounder, who in turn depended upon his vague experience rather than upon scientifically assembled data. The modern rubber industry has not yet accorded the necessary study to this important class of materials. Even stearic acid, a "softener" almost universally used in the tire industry, has not received all the study it warrants.

The designation "softener" is an unfortunate one and leads not only to confusion in language but also to injudicious substitution of one softener for another with-

out knowledge of the actual similarities or differences between the original material and the substitute. If "softeners" merely softened the rubber this might be excusable. As a matter of fact, the softening effect obtained is merely one of a number of important modifications. Sometimes contradictory results may be obtained by a replacement of one "softener" by another. Many compounding difficulties can be traced to the use of the improper "softener" or the improper use of the right "softener."

Rubber "softeners" are depended upon for a number of different effects, some of which are as follows:

- To cheapen by diluting the rubber, or facilitating higher loading with fillers.
- To reduce power consumption and avoid excessive temperatures and working of rubber.
- To increase ease and speed of operations as mixing, extruding and moulding.
- To alter tackiness; promoting or reducing adhesive properties.
- To reduce porosity and granular structure, thereby obtaining improved electrical, water-proofing and air tight properties.
- To alter rate of vulcanization.
- To improve aging.
- To improve dispersion of pigments.
- To improve wetting of pigments and textiles.

There is no universal rubber "softener" which will do all or most of these things. Ceresin or paraffin wax will enhance electrical properties, whereas the solid asphalts are of very little value for this purpose; on the other hand, these asphalts are better suited for reducing the costs of mixes by dilution of the rubber binder. The tire industry is compelled to include both stearic acid and pine tar in almost every tire tread in order to obtain the specific effects of each. But the general knowledge of the effects of "softeners" almost ends here. Yet the tensile strength, modulus at given elongation, elasticity, stiffness, and other properties are markedly affected by mere changes in the "softener."—*Industrial Bulletin*.

EXPLODING WOOD

Several years ago I was perfecting a process for extracting rosin and turpentine from Southern pine boards to recover these substances and raise the grade of the lumber. In traveling from one mill to another I was impressed with the great waste in slabs, edgings, board ends and sawdust, most of which was consumed in the trash burners. To find a way to convert this wood waste into wood pulp became a fixed purpose.

Power costs for mechanical grinding are too high and the gums from the pine quickly impair the efficiency of grinding surfaces. The chemical process was unattractive because of high cost for plant, loss of nearly half the raw material in the digesters and the difficulty of treating the bark.

The problem was to separate the fibers without losing the lignin. Wood is plastic when subjected to heat and moisture, probably due to some change in the lignin. Would it be possible both to soften the lignin and to blow the fibers apart, with steam? Could one apply temperature and moisture in such manner as to soften the lignin more than the cellulose fibers without injury to the fibers, and create a pressure within the wood sufficient to disrupt the fibers upon the instantaneous removal of the surrounding pressure?

In 1924, I set up an experimental plant in a shed next to a sawmill at Laurel, Mississippi. My first steam gun was a piece of old steel shafting about three inches in diameter and fifteen inches long with a hole bored into it from one end and enlarged inside to twice the diameter of the entrance. Through one side a small opening was drilled and a brass cup for holding oil secured in it so that temperatures inside the gun could be taken with a thermometer. The outside of the gun muzzle was tapered to a ground valve joint. The valve, closing the gun, was held in place by a pin, supported by a yoke surrounding the gun and bolted to its breech.

The gun was filled with chips and water, and closed. Then two gasoline torches were directed against its side until the temperature inside rose to 480° Fahrenheit, indicating a pressure of approximately six hundred pounds per square

inch. A four-foot bar was placed with one end against the pin. A smart blow with a hammer on the other end of the bar knocked the pin loose and allowed the valve to blow out.

The first experiment completely reduced the chips to fiber, but it took a long time to find the valve. The principle of steam explosion of wood had been demonstrated. Further experiments were needed to determine the best steam pressures, temperatures and time intervals. For weeks this crude gun was used with different kinds of wood,—varying pressure, temperature and time.

Subsequently, two other experimental guns were constructed, in which pressures as great as nine hundred pounds were used. It was learned that time was as important as steam pressure and temperature. Present practice is to subject the chips to a low pressure of two hundred pounds for ten to fifteen seconds and then to pressure of one thousand pounds for three to five seconds before blowing them from the gun.

Naturally we hoped to make paper from this pulp, but have not yet produced a satisfactory quality and therefore turned our attention to other possibilities.

The exploded pulp was found especially suitable for the manufacture of insulating boards for a large variety of uses. In a beater made out of an old gear, and some angle irons for a bed-plate, the fiber was worked over, formed into a board by hand, compressed to one-third volume in an old letter press, and dried in an oven. By further experimentation processes for production of the insulating board were perfected. It was named Masonite.

For making another product a hydraulic jack was tried, using pressure as high as five thousand pounds per square inch to compress the pulp; but the resulting board, although fairly hard, had no characteristics out of the ordinary and so the experiments were temporarily abandoned.

Later we found a steamheated press and one morning put some insulating board in it for further compression, shut off the steam, went about other work and forgot it until after dinner. Then we found the press hot because of a leak in the steam

valve. Upon opening the press we were surprised to find a hard, dense board stuck to the felts, possessing unusual qualities.

Four months of experimentation developed processes for producing boards with hard dense surfaces and porous, insulating interiors, which we called Presdwood. It is very dense, stiff and hard, and has a tensile strength in any direction of

four thousand to five thousand pounds per square inch. It comes from the press with one side polished and can take any finish that can be applied to ordinary wood.

Further research and experience may develop possibilities still unsuspected for this process for producing wood pulp from wood waste.—*W. H. Mason, Research Narrative No. 137, Williams & Wilkins Co.*

SILK FROM PEANUT SHELLS

Rayon from peanut shells is under investigation by the Farm Wastes Division of the Department of Agriculture at Arlington Farms, Virginia, with results which seem to promise a large raw-material supply for viscose producers. Over 70,000 tons of peanut hulls are collected annually in southern shelling plants, but little use is made of them except as fuel for plant power. The fact that the hulls

are collected is a point in their favor, since many other types of waste which might be used could not be made available in bulk without heavy collecting costs. Research shows that a product up to 90 percent alpha cellulose content can be derived from peanut shells, the requirement of good rayon material thus being satisfied. Experimental fibers have been produced.—*A. E. Buchanan.*

JAPAN'S PROGRESS IN PAPER MAKING

The Japanese have made remarkable strides during recent years in the manufacture of machine-made paper, according to a study of the paper trade of Japan which the Commerce Department has issued as a trade bulletin. At the present time, Japan ranks with the leading paper-producing countries in volume of output, being surpassed only by the United States, Germany, the United Kingdom and Canada.

The manufacture of machine-made paper ranks among the most progressive and prosperous of Japanese industries. An ample supply of working capital, together with an efficient management has in most cases insured the plants being equipped with the best modern machinery and labor-saving devices; its forests provide an

abundant supply of pulpwood and its numerous waterfalls make the industry independent of foreign sources of supply of basic raw materials and power.

Japanese output, however, is confined largely to printing papers, particularly newsprint, the report shows. Notwithstanding the important domestic industry, the Japanese market each year absorbs between \$7,000,000 and \$10,000,000 worth of imported paper and paper products. The American share in this trade has averaged somewhat less than 10 per cent annually, as against 25 to 35 per cent enjoyed by Sweden and approximately 20 per cent each by the United Kingdom and Germany. Japan is strictly a price market, it is pointed out, and the greatest demand is for the medium and cheaper varieties.

SOAP

The first authentic record of soap is found in the literature of the Roman Empire. The Romans regarded it chiefly as a medicament, although Galen, the famous physician, is on record as stating that it softens and removes dirt. Pliny first described the manufacture of soap, attributing its invention to the Gauls and saying the "best is from beechwood ashes and goats' tallow."

The manufacture of soap was a small but definitely factory industry in Pompeii, as revealed by recent excavations. During the Middle Ages, however, it was carried out mostly as a home industry as it was even up to our own time. Most commonly, leached wood ashes and refuse household fats were used. In the Mediterranean countries soap was made from olive oil, resulting in a product far surpassing the majority of the other soaps then being made and early established the reputation of "Castile" soap.

RISE OF MODERN SOAP INDUSTRY

The modern soap industry followed closely after the LeBlanc process for production of soda ash which was first put into practical operation by James Muspratt in England in 1824. Chevreul in 1813 had established the fundamental chemistry of fats and this started the soap industry upon a scientific basis.

During the last hundred years the methods and machinery of soap production have been gradually but vastly improved. The small fire-heated kettles have been replaced by huge steam-heated kettles. Pumps, mechanical agitators and automatic and semi-automatic stamping and wrapping machinery have replaced hand labor. The raw materials now come from far parts of the world. Coconut, palm and palm kernel oils are extensively used. Domestic fats, including tallow, are carefully collected and refined. The hydrogenation of fats, a chemical treatment which produces a harder fat from soft fats, and similarly a harder soap, is also sometimes practiced. Carloads of caustic soda are used which must pass requirements that would have been impossible to meet a few years ago.

The recovery of glycerine from the spent lye and its purification has become a vast industry. Glycerine was not known until the early 19th century, but today finds the most diverse uses; for example, in cosmetics, explosives and as anti-freeze for automobile radiators.

The earlier commercial soaps were all frame soaps, *i.e.*, the warm soap was poured into molds or frames and allowed to cool and harden. It was then cut into bars. This method, modified and improved, is still used extensively for kitchen and laundry soaps.

TOILET SOAPS

Practically all of the modern toilet soaps are made by the recently-developed milling process. In this process the hot "neat" soap is chilled and rolled into chips which are dried and run through mixing mills. The dried mass is then compacted and extruded through a machine called a plodder from which it comes in a continuous bar which is cut into cakes ready for the final stamping. This process gives a soap of low water content which keeps well and permits the use of delicate perfumes.

The latest available U. S. Commerce reports indicate that each man, woman, and child in this country consumes an average of 9 to 10 cakes of toilet soap each year. Also, each one uses or has used for him nearly twenty-one pounds of soap in forms other than toilet soap. The estimated yearly cost for soap for a family of five is about \$17.50. Expressed differently, it costs each of us one cent per day for cleanliness via soap.

During the last few years soap chips, powders and flakes have been popular for industrial and laundry use. Lately, "puffed" soap in granule form for rapid solution in lukewarm water has become prominent. The production of these special forms has necessitated the development of much new machinery.

PERFUME AND COLOR

A few decades ago perfume and color in soap was regarded by many and often rightfully as a cover for inferior ingredi-

ents. A decided trend toward white, nearly odorless soap resulted. More recently there has been an increasing demand for delicately perfumed white milled soaps. As yet, the vogue of color in the kitchen and

bathroom has had little effect on soap. We may, however, expect to find a demand for the more delicate pastel shades, appropriately perfumed, in the near future.—*Industrial Bulletin*, Arthur D. Little, Inc.

ANIMAL CHARCOAL

Bones collected from the packing industry now figure directly in at least three important fields of manufacture: fertilizers, animal glue, and bone black or animal charcoal. Owing to its physical structure, bone black has a strong affinity for organic coloring matter and thus has been used as a decolorizing and clarifying agent in the manufacture of many products, especially vegetable oils, fruit juices, glucose and sugar, the last two taking the bulk of the product.

Bone black is made by the destructive distillation of bone, practically all of the organic matter being driven off, leaving a very hard and porous calcium phosphate skeleton covered with 9 to 12% of active carbon which affords an extremely large absorbing surface. The volatile matter is cooled and washed with water to recover ammonia, and the bone tar is generally cooked down to bone pitch, though there is some outlet for it in special paints or coatings. Because of its nitrogen value, the distillate from the pitch still, bone oil, is sometimes used for fertilizers, but more often it is burned under the retorts. It is understood that bone pitch has some merit as an electrical insulating material, though its odor precludes wide industrial use at present.

In recent years there has been a tendency in the vegetable oil and fruit juice industries to supplant bone black by in-

fusorial earths or vegetable decolorizing carbons.

In the early days of bone black manufacture it was possible to choose carefully the bones used. Now, however, the supply has become limited and the better bones are being taken by other industries, thus leaving to the bone black manufacturer poorer material at a higher price, with the result that competition with other decolorizing agents has been made increasingly difficult. However, the probability of any immediate change by the glucose and sugar industry is slight; due in part to the prohibitive cost of remodelling the plant and partly to improvements in methods of manufacturing and revivifying the black whereby the ultimate costs have been materially reduced. It is also understood that new sugar houses are being designed to use bone black. It is probable that some trade now lost to the bone black maker may eventually be regained as a result of improvements in manufacturing and revivifying methods.

Comparatively little time has been given in the past to the study of bone tar, but the interest in synthetic resins and plastics combined with the improvements in condensation, washing, and distillation equipment developed by the oil industry indicate that a careful study of this material may yield products of considerable value.—*Industrial Bulletin* of Arthur D. Little, Inc.

SEAMLESS, ENDLESS TUBE BY ELECTROLYSIS

By forever pulling off the metal sheath as it is deposited out of solution on an iron alloy core, Prof. Jean Billiter of the University of Vienna makes seamless and endless tubing of copper, zinc and iron.

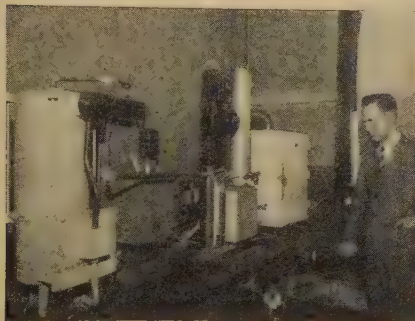
But this, his first method, was too slow, he told the American Electro-chemical Society in St. Louis recently; only a few

inches of tubing could be made in an hour. Therefore a faster method was devised.

A lead core is now run continuously through the solution and metal is deposited on it as the core moves. Then the soft lead is melted away and the copper, zinc, or iron tubing left. A tube five yards long and nearly one tenth of an inch thick can be made in 24 hours.—*Science Service*.

OZONIZING OF TEXTILE FIBRES

A number of years ago it was observed in the Westinghouse Electric and Manufacturing Company Research Laboratories that ozone treatment increased the tensile strength of cotton tape. This effect increased with concentration of ozone and rise in temperature up to a certain point, when it dropped off in the same degree.



Recent investigation in the Westinghouse Laboratories seems to prove that the effect is not caused by a reaction of or with the cellulose fibre proper. Since the primary action of ozone is oxidation, the effect must be explained on the basis of this reaction. It is well known that oxidation of the cellulose molecule destroys it and one would not expect increased strength on that basis. Consequently it was decided that the action was caused by some foreign material in the fibre. As the

effect was first noted on a relatively crude unbleached cotton, this material was investigated and found to contain an appreciable amount of natural vegetable oils. These oils were removed from cotton yarn by the use of suitable solvents. Ozonization of the extracted yarn showed no increase in tensile strength, rather a small decrease. Since this agreed with the original hypothesis, the extracted yarn was then impregnated with small amounts of drying oils, such as linseed, cotton seed or china wood oil. Tensile strength tests on the impregnated samples showed considerable decrease, but subsequent ozone treatment caused a decided increase in strength. It was concluded from these experiments that ozonization of relatively pure cellulose decomposes the molecules, that impregnation with oils lubricates the fibres, and causes decreased friction, and finally, that, within limits, the oils may be cured so that intra fibre friction is increased to a marked degree and the tensile strength of the thread increased as high as thirty-five per cent. A slight increase is noticed on the individual fibres because of the coating of dried oil but the main effect is caused by increased friction between fibres. This makes yarn failure due more to breaking of the individual fibres than to slippage past one another.

The photograph shows E. R. Perry, Research Engineer, Westinghouse Electric and Manufacturing Company, beside the apparatus he has developed for ozonizing textile fibres.

FIREWORKS EXPENDITURE

It is estimated that the American Public spent \$6,500,000 for firecrackers and fireworks on Independence Day this year, according to a statement of the Bureau of Foreign and Domestic Commerce. This estimate is exclusive of the expenditures on toy pistols, blank cartridges and noise makers of that sort which come under the classifications of toys and are used all year.

The expenditures for this type of goods is steadily declining, but the decline is slow. From the 1925 Census of Manufactures to the 1927 Census, a decline of two per cent in production of fireworks was shown. It is believed that when the 1929 Census is complete, a similar reduction will be shown. The police restrictions on the use of fireworks are largely responsible for this drop.—*Trends and Indications.*

DEAD SEA DEVELOPMENT

When William Francis Lynch, officer of the U. S. Navy, sailed his boat around the Dead Sea back in 1848, on the first scientific tour ever made of that curious body of water, he took extensive notes on every possible aspect—except the 42 billion tons of salts just 250 feet below him. And for many years after, explorers were content to skim the surface, till Mr. Novomeysky came down from Siberia.

In 1911 he made chemical analyses from samples of the water which a long experience of mining engineering had convinced him was a pool of great mineral wealth. The results amazed him with the astronomical amount of potassium, sodium and magnesium chlorides and magnesium bromide assembled within the Sea. Then, while he carried out successfully attempts at extracting the salts, in a private enterprise bordering on the shore of the Sea, the Great War sent Allenby with his troops into Palestine. Although the military activities naturally absorbed the best part of his program, the chemical possibilities visioned in Dead Sea potash led one of his most far-seeing officers, Major Tulloch, to start an investigation of his own.

Skipping several years, the result of much ebullient interest was the granting of a concession by the British Government, mandatory over Palestine and Transjordan, to Mr. Novomeysky and Major Tulloch jointly, in 1929. In the same year Palestine Potash, Ltd., was organized at London, with a capital of \$2,000,000 and the Earl of Lytton as chairman. Five British firms and one American firm (the Palestine Economic Corporation of New York) have representatives on the board of directors.

Palestine Potash, Ltd., is invigorated by

the same spirit which eighty years ago led Lynch to go exploring a strange sea. Here the nature of the work involved is not radical, yet, owing to the creative imagination of a few individual minds, the rest of the world has been stirred to realize that one of its favorite concepts is no longer tenable. The Dead Sea is very much alive.

Huge concrete evaporating pans have been constructed to hold the brine, electrically pumped from the Sea. The intense solar radiation evaporates most of the water; the sodium, potassium and magnesium chlorides, and the magnesium bromide crystallize out in turn from their respective mother liquors, in a process involving four stages. Photographs recently received in New York and reports by the Palestine Economic Corporation indicate that rapid progress has already been made.

At first probably only the potassium chloride will be exploited. To those acquainted with the chemical markets of the world it is obvious how all this may break into the well-laid plans of the German Potash Syndicate, with the odds possibly in favor of Palestine Potash. Even the cost of transporting salt from the Dead Sea to the port of Haifa appears to be more than offset by the estimated production cost advantage. Cheap power from the Jordan, where a hydroelectric plant has been built to electrify all Palestine, will be a distinct aid to the organization. Palestine and Transjordan themselves offer good markets in the first years of production, while within reasonable distances of the Holy Land are vast areas, once teeming with crops, now in sad need of the large amounts of fertilizer eventually to be recovered.—*Industrial Bulletin, Arthur D. Little, Inc.*

NEW PLASTIC FROM CORNSTALKS

Out in the "corn belt," chemists have dreamed of converting the useless cornstalks into a useful article of commerce. Indeed, the dreams have been realized to a certain extent by the recent perfection of a process for making wall board from the stalks that were formerly useful only as Hallowe'en decorations. The most obvious use, however, namely their conversion into paper, has thwarted the efforts of chemists, mainly because of the difficulty of overcoming the tendency of the pulp to hydrate, a property which seems characteristic of this material.

Scientists at Iowa State College finally hit upon the idea of turning this stumbling

block into a benefit, and have produced a new material known as "maizolith." This material is somewhat like hard rubber in appearance and properties. It is believed that cornstalks may eventually find their way into the manufacture of insulating material, noiseless gears, and similar products. It has been found rather easy by severe chemical and mechanical treatment to hydrate the cornstalk completely so that the product is a jellylike mass with no vestige of fibrous structure. Maizolith is prepared by drying this jelly and then machining the finished piece into the desired shape.

ELECTROLENE—A NEW GAS

Announcement has recently been made of a small electrically operated unit whereby ordinary city gas—containing methane and illuminants that burn with a smoky flame—is converted into a gas consisting almost entirely of hydrogen and carbon monoxide. The resulting gas is for many purposes equal or superior to pure hydrogen and costs only one-tenth as much. It burns with a clear blue flame, and does not deposit soot. The tempera-

ture of this flame is practically as high as that of hydrogen. Its chief field of use is in industrial furnaces where a reducing atmosphere is required, and for certain high temperature processes such as gas welding and brazing. Not only will the new gas, which has been named "Electrolene," be a vigorous competitor of hydrogen but it will undoubtedly enter new fields of its own on account of its low price.—*Industrial Bulletin*.

CARBON REMOVER

It is a well-known fact that if a gasoline engine of the poppet valve type can be kept relatively free of carbon, the intervals between necessary removals of the cylinder head can be increased greatly. In the article "Your 1930 Car," published in our January 1930 issue, we mentioned a product of the Alemite Corporation, called Carbosolve, which has been installed as standard equipment on Chrysler cars.

This carbon removal system is now available for use on all cars, having recently appeared on the market in "kit" form. Essentially, it involves the use of a valve permanently mounted on the dash, and with a connection to the center of the intake manifold. The valve is so arranged

that a can of the special carbon-removing liquid can be attached when it is desired to treat the explosion chambers. The makers recommend that this be done every 500 miles.

When the device is to be used, a can of the liquid is attached to the valve, the motor is warmed up to running temperature, and the valve knob is pulled out and the motor shut off simultaneously. The liquid is sucked out of the can and is equally distributed to the cylinders. The engine is then allowed to stand undisturbed for at least three hours, or overnight. It is then started and the carbon, loosened by the action of the liquid, is blown out with the exhaust.

MAIZOLITH FROM CORNCOBS

Maizolith, a substance hard as stone and stronger than most kinds of wood, is one of the newest products of chemical magic working on cornfield wastes. It can be made from any part of the corn plant, but most advantageously from corncobs. It is one of the things that have been made by the chemists of Iowa State College at Ames, and has recently been undergoing tests on a semi-commercial scale at the U. S. Bureau of Standards in Washington.

It is prepared by chemically digesting the corncobs, reducing them to a uniform jellylike pulp in certain standard paper-mill machinery, and pressing the jelly in a mould. The resulting solid material is a

dense, hard, bonelike substance, ranging in color from a golden tan to a deep ebony. It is somewhat stronger than the hardwoods, and is a good electrical insulator. It can be machined and polished into non-metallic gears, washers, panels and other objects such as are now made from hard rubber and bakelite.

It is estimated that a commercial plant with a production capacity of five tons per day could manufacture it at a cost of about \$240 a ton. The cost might be cut if it is manufactured as a by-product in other cornstalk industries.

Its trade name, maizolith, englishes into "corn-stone."—*Science Service*.

NATURE'S RED COLORS

PRODUCED BY ELECTRO CHEMISTRY

Nature's supply of "bloodstone" and natural iron oxide, which form the source of turkey red shades in paints and decorations, is being rapidly exhausted. Pigments of the darker shades can be made artificially by heating a copper ore to a powder. The lighter tints are much harder to attain.

But they can be produced by electroly-

sis, Walter H. Bruckner, of Columbia University, told the American Electrochemical Society. Direct current passing from pure iron terminals through a sodium sulphate solution will cause iron hydroxide to be precipitated. The hydroxide can be gotten in fine-grained pure form and makes an excellent pigment for light red tints, he said.—*Science Service*.

NEW ALLOY IN PLUMBING INDUSTRY

The British discovery of a new ternary-lead alloy—with which it will be possible to produce sheets and water pipes superior to and cheaper than those made of pure lead, and having only two thirds of the weight, has been announced. The new alloy, which was discovered by the British Non-Ferrous Metals Research Association in the course of investigations to find the cause of breakdowns in lead cable sheathings, consists of 98.25 per cent lead, 1.5 per cent tin, and 0.25 per cent cadmium. Tests show that it possesses the following advantages over pure lead: Pipes made from it will be cheaper, having only two thirds the weight; its ultimate tensile strength is 84 per cent greater; its resistance to vibration is 217 per cent greater; in certain corrosive waters

its resistance is superior to lead itself.

A ton of ternary alloy costs 10 per cent more than lead, taken on the basis of metal costs, but the ternary alloy will give 33½ per cent greater length and superior mechanical strength of pipe, for the same weight of lead, so that there is a gross margin of saving amounting to 23 per cent. There is a small extra manufacturing cost but the net savings make the alloy pipes considerably cheaper. Another saving will be on carriage charges. Lead sheets are subject to "creeps." The tin-lead alloy, which has a greater resistance to corrosion, is 300 per cent less ductile than lead.

There seems to be good reason to believe that this alloy will take the place of lead pipes and sheets throughout the world.

EVERDUR

A HARDENED COPPER

Ancient methods of hardening or tempering copper are frequently referred to as among the lost arts, but, even if the legend were true, the rediscovery might be of little practical value in view of recent progress in hardening and strengthening copper by alloying with small percentages of other elements. One of the most interesting of such alloys is Everdur, a patented product developed in the research laboratory of one of our largest chemical companies and now made by a leading brass manufacturer.

PHYSICAL PROPERTIES

As described by the producers, Everdur contains silicon and manganese in different proportions for the cast and wrought forms and combines a strength approaching that of steel with the non-rusting and corrosion resistance properties of copper.

Soft annealed, the wrought forms—sheets, rods, tubes, wire and forgings—have a tensile strength of 55,000 pounds per square inch, a yield point of about 15,000 pounds per square inch, an elongation in 2 inches of 60 to 90% and a reduction in area of 60% or more. Small rods hardened by rolling or drawing have a tensile strength of 95,000 pounds per square inch, a yield point of about 80,000 pounds per square inch, an elongation of about 15% and a reduction in area of 50% or above. In the form of spring wire, the tensile strength is 145,000 and the yield point approximately 100,000 pounds per square inch. The modulus of elasticity is 15,000,000. Its density is 8.46.

An outstanding property of the annealed tube is its high resistance to fatigue by vibration. It is 350% more resistant than annealed brass, 252% more resistant than annealed copper and 237% more resistant than annealed aluminum.

Hot rolled Everdur will meet the requirements for steel boiler plate in the code of the American Society of Mechanical Engineers. Because of its corrosion resisting properties and strength, it therefore makes an excellent material from which to construct hot water storage tanks for office buildings, hotels and apartment houses.

This material may be readily worked either hot or cold, machines well, can be welded either by oxy-acetylene or electric arc and may be brazed or soldered in the same way as copper or bronze. It casts well, producing green sand castings above the range of strengths obtained in gun metals and similar tin-bearing alloys. Because of its ease of fabrication as compared with non-magnetic steel it can be used in the construction of electrical equipment such as transformer apparatus, switch gears, and the like.

OTHER APPLICATIONS

Everdur is finding application in the replacement of iron and steel where strength, combined with freedom from rust and resistance to corroding gases, vapors and liquids, is essential; in castings, pumps, pump linings, pipes, valves, fittings, bolts, nuts, rivets, wire screens, etc., and in the construction of ventilating ducts, fans in battery rooms and pickling houses and acid drainage systems. It is obtainable in the many various forms required for such uses.

Because of its excellent strength, machining quality and ease of handling in the foundry, this type of alloy may eventually replace tin bronzes now used in foundry work, an application of potential importance in light of the limited visible supply of the world's tin.—*Industrial Bulletin*.

FRUIT ACID RECOVERS TIN

It is common knowledge that the acid in some fruit juices attacks the tin of the container. This annoying property may be turned to advantage by the chemist, if a newly devised method of recovering the tin from old tin cans proves to be feasible. The recovery of tin from old cans and other tin-plate materials has been attempted by many methods, most of which have been unsuccessful. The few successful detinning plants have employed the chlorine, alkali, or electrolytic alkali process. In the past two years most of the detinning plants in operation have been closed because of the low price of tin.

W. W. Scott and N. E. Davis of the University of Southern California have developed a detinning process based on the fact that dilute solutions of tartaric acid dissolve tin in the presence of an excess of air or oxygen while iron is unattacked. When tin-plate scrap is placed in dilute tartaric acid solution, tin is dissolved at the surface of the solution. In order to

effect a more rapid solution of tin, it was found necessary to provide a rotating cylinder in order to assure uniform contact of air and acid on the tin-plate material being detinned. The solution after detinning, contains stannous tartrate. The tin may be recovered from the solution by precipitation, as sulfide with hydrogen sulfide. The tin from stannous tartrate is replaced by the hydrogen from hydrogen sulfide and tartaric acid is recovered. There is a slight loss of tartaric acid in this reaction owing to decomposition, which is about 0.10 gram of acid per gram of tin recovered. The tin sulfide may be converted into the chloride by treating with hydrochloric acid. The detinned scrap contains about 0.10 per cent tin, which is sufficiently low to be suitable for steel smelting. In the detinning of old tin cans it would be necessary to clean the cans first with hot sodium hydroxide or carbonate. The presence of grease and lacquers will inhibit the action of tartaric acid on tin.

FREAK METALS FIND USES

Two rare metals, caesium and rubidium, formerly known as chemical curiosities, have found their first important commercial use as a result of the development of radio and photo-electric cells. Both these queer metals, members of the alkali group, are soft enough to be cut with a knife and have to be kept in a vacuum, else they ignite spontaneously, due to their extreme chemical activity. This very property is now being utilized in the manufacture of radio tubes. The caesium is introduced into the tubes in the form of chloride, mixed with magnesium or calcium, and compressed into small tablets or "pills." At one stage in the manufacture of the tube the pill is flashed, eliminating the last trace

of air and thus securing the desired vacuum. The caesium chloride supplies positive ions at the surface of the filament.

Both caesium and rubidium are employed to a limited extent in the manufacture of photo-electric cells. Rubidium, however, appears to be more suitable for this than caesium, because an extremely thin layer can be applied on the inner side of the glass. In the manufacture of these cells the metal, either caesium or rubidium, is introduced in excess but later is removed entirely except for the molecular layer that has formed on the silver or other base-metal electrode. The photo-emission of the molecular layer is greater than that of the massive metal.

XYLOSE

A NON-FATTENING SUGAR

One and a half million tons of waste cotton seed hull bran may find a use in making xylose, a non-fattening sugar, it was announced by the American Chemical Society, in making public the results of research by Dr. W. T. Schreiber and associates at the Bureau of Standards, Washington.

The semi-commercial production of this new sugar has been accomplished in a plant at Anniston, Ala., built and equipped by Theodore Swann, President of the Swann Corporation.

About two years ago, the Bureau of Standards was authorized by Congress to investigate and to develop uses for the so-called waste products from the land. Following laboratory research on many of these products at Washington, the experimental semi-commercial plant for the production of xylose from cotton seed hull bran was established as a co-operative project of the Alabama Polytechnic Institute, the University of Alabama, the Swann Corporation of Birmingham, and the Bureau of Standards.

Xylose is a five-carbon sugar. It is not new to the scientific world, although until recently it sold at the exorbitant price of \$100 per pound. This was true despite the fact that xylan, the condensation product from which it is obtained, is, next to cellulose and lignin, probably the most widely distributed organic compound found in nature. Koch, its discoverer, isolated xylan from wood in 1886. Since then it has been obtained from innumerable plant materials. It has been found in various grains, straws, gums, woods, parts of the corn plant and other plant substances.

There was little interest in xylose until the World War, when the greatly increased demand for acetic acid directed attention to it. The reason was that the fermentation of xylose with certain bac-

teria found in silage, soil, etc., gives acetic and lactic acids.

Cotton seed hull bran contains between thirty and thirty-five per cent pentose. This is a greater percentage of pentose than is found in any other known plant material. The possible production of cotton seed hull bran in this country is between one and one-half million tons per year. This material has the decided advantage of being one of the few waste products from the land which is already gathered.

Cotton seed hulls are collected at the cotton oil mills. A few mills remove the fuzz for use in making rayon and paper. Yet the market for hull bran is exceedingly limited. Only a very small amount finds use as a filler in cotton seed meal and cotton seed cake. It was for these reasons that the Bureau of Standards decided to work on cotton seed hull bran.

The purposes for which the experimental xylose plant was built and operated were in the main as follows:

To prove that xylose could be made from cotton seed hull bran on a semi-commercial scale with more or less standard equipment.

To produce a sufficient quantity of xylose to meet the needs of those investigators interested in finding and developing uses of xylose.

To develop and thoroughly test a process which will produce economically a good grade of xylose on a semi-commercial scale.

To obtain sufficient data from which probable xylose costs when made on a plant scale might be calculated.

The process now available will produce this five-carbon sugar, a product whose potentialities are still to be fathomed, from a vast annual supply of a very cheap raw material.

THYRITE

BOTH AN INSULATOR AND A CONDUCTOR

An entirely new type of material, one that is both a good insulator and a good conductor of electricity, was announced by K. B. McEachron of the General Electric Company recently in New York City. This material, which has been called Thyrite, meaning gate or valve, has the remarkable property of changing its resistance to the flow of electricity as the voltage or pressure is changed. This change in resistance is such that each time the applied voltage is doubled, the resistance decreases so that the current flow is increased more than 12 times. This means that if the voltage is increased 16 times the current flow is increased more than 25,000 times.

The usual conductor with which electrical engineers are familiar does not change in resistance except when the temperature of the conductor changes. To illustrate: the tungsten filament in the Mazda lamp increases its resistance considerably as the filament heats up; the carbon lamp shows, on the contrary, a decrease in resistance as the filament increases in temperature. With either of these materials the resistance change is slow since it depends on the time required to heat the filament. Unlike any materials now in commercial use, the resistance change of Thyrite does not depend on the temperature, but on a change in the applied voltage. Thyrite will change its resistance as quickly as the applied voltage changes; in fact, tests have shown that the resistance can be decreased to a millionth of its original value in a time as short as a millionth of a second.

Thyrite is a manufactured product which required more than five years if intensive research to develop to the state where it can be produced commercially.

Mr. McEachron exhibited some disks six inches in diameter and three-fourths of an inch thick, made for use in lightning arresters for the protection of power stations against the damaging effects of lightning. Such disks have a resistance of about 50,000 ohms when 100 volts are applied to the parallel faces; the resistance decreases to less than one half an ohm when the voltage is increased to 10,000 volts. These disks of Thyrite will carry lightning discharges as heavy as 30,000 amperes without any sign of distress.

The characteristics of Thyrite are permanent. Some of the first material made is still on life test, with no change in its characteristics, even though it has been carrying current continuously night and day over a period of several years.

Thyrite resembles black slate in color. It has mechanical properties similar to those of dry-process porcelain. In manufacturing it, the material is moulded to the shape required, and the contact surfaces coated with metal by the Schoop metal-spraying process.

It is possible to use the material successfully on any alternating or direct current circuit; it is necessary only to supply a proper amount of the material so that it will not become overheated.

In connection with lightning arresters, Mr. McEachron explained that the use of Thyrite allows a considerable reduction in the space occupied by the arrester, and that it is possible to calculate its performance accurately. This feature will be of great assistance to engineers using such protective equipment. Furthermore, it was pointed out, it is possible for anyone to determine the characteristics of Thyrite over a considerable current range, without the use of expensive equipment.

USE OF RARE METALS

Of the more than fifty elementary metals known, less than half have as yet come into the service of industry. Yet, year by year, with the growing demand for metals that will stand extremes of corrosion, heat and wear, metals of peculiar characteristics, metals for new uses, shifts are observed from the category of those that are mere names to that of those on which entire processes of great importance to modern civilization depend.

Aluminum was once among the least known; now no home is without it. Other metals now are going through a similar process of utilization and familiarization. The average man may never have heard of tantalum, but he would soon know the difference if he had to do without it. This is one of the metals that science and industry have plucked out of the unknown to make modern living more efficient. Tantalum was first found more than a century ago, but for 100 years it remained a baffling mystery. In 1903 a process was developed for drawing tantalum into a fine wire, and then it began to be used as a filament for incandescent lamps.

Tantalum made possible the trouble-free charger of today's radio battery. Tantalum maintains the vacuum in radio tubes. It serves as the electrode in the tubes of the now familiarly brilliant neon sign, and artificial silk is what it is because tantalum spinnerets are used for spinning the shimmering fibers. Laboratory equipment made from tantalum is inert to practically all chemical action and costs

only a fraction of the platinum it replaces.

It gives precision instruments—for recording time, temperature, pressure and so on—resistance to corrosion, keeps writing pens unaffected by ink, and for its iridescent finish and its high polish has gained favor in cases for watches.

Tungsten is another of the rare metals that is becoming familiar. Every one has heard of tungsten steel and tungsten lamps, whether they know what the term means or not. If this planet were about 1,000 degree hotter, it is said, tungsten would have the place of iron and steel. As it is, this metal is so hard to handle that it remained little known till makers of electrical equipment came to see its advantages.

About one-half of the world's tungsten production comes from China. Most of it is used to make steel harder. About five tons a year are used for lamp filaments and only a very little for manufacture of the pure metal. In factories it is responsible for high speed machinery that cuts production costs. It serves, too, in the ignition system of automobiles and in automatic street traffic signal devices.

Without molybdenum the radio sets would not be at all what they are. The ether carries the wave that brings the broadcast to the set, but it is molybdenum, sealed tightly in tubes, that, so to speak, puts the wave on the air and picks it out of the air again. It eliminated the trouble, common with early tubes, of grids softening.—*N. Y. Times.*

CLINOMETER

MEASURES AVIATOR'S CEILING AT NIGHT

The clinometer, a simple device which enables one man to determine quickly the aviator's "ceiling" at night has been designed recently by Dr. C. F. Marvin, chief of the U. S. Weather Bureau, and is being put in use at army and navy flying fields.

It is used in connection with a searchlight focused vertically on the clouds. At a certain distance from the light, often 1,000 feet, the observer sights the clinometer on the white spots on the clouds and

measures the angle of sight with a pendant which hangs on a scale attached to the instrument. Then with the ground distance and angle of sight known, the vertical height of the clouds can be readily calculated as the leg of a right triangle.

In the daytime, ceiling height is usually measured by sending up a balloon. A crude instrument depending on the same principles applied in the clinometer has been used in the past to make this determination at night.—*Science Service.*

WELDING COPPER

Until recent years it was considered that the satisfactory welding of copper was impossible. The high thermal conductivity of the metal gave rise to grave practical difficulties, and even if these were overcome it was found that the copper became brittle by the action of the gases in the acetylene flame. As the result of recent research work, however, a process for welding copper has now been evolved which renders the operation simple and safe, provided the correct materials are used.

A demonstration of this welding was carried out recently at Swansea, England. At this demonstration copper pipes were welded together without difficulty and the joint subjected to severe flattening and bending tests, the results of which proved conclusively that the weld would withstand conditions of service as satisfactorily as the pipe itself. Sheets of copper were also joined together by the welding process, and it was shown that these would withstand a considerable amount of work and stretching; in fact, as much as the solid copper itself could be expected to withstand. The welding of varnish-pot seams was also demonstrated, a process which eliminated a great deal of troublesome riveting. It was observed that the welding operator worked quickly and as easily as if he were merely brazing the pieces together, and after the weld had been made and trimmed it was difficult to see where the joint occurred, while it had a tensile strength equal to that of rolled copper.

The demonstration proved that the dif-

ficulties previously associated with the welding of copper had been overcome, and it is certain that there is a wide field in industry for the application of the process. Riveting will be largely eliminated, and vessels which previously had to be forged out of solid copper—a very expensive procedure—can now be built up by welding sections together. All this has been achieved by means of slight modifications in the technique of welding ferrous metals, by the use of copper alloy filler rod and flux of the appropriate type.

The copper that has been developed for welding purposes is not attacked by the gases of the acetylene flame, and it is essential to use this copper if the weld is to be perfectly satisfactory. The copper is a modification of the tough pitch variety, supplied at the same price, but not inferior to it in any way; in fact, it might be expected to give better service generally. The filler rod, again, is of specially modified copper, which is very fluid when molten, and so runs well into the joint, leaving no air locks or gaps. It is essential to use this filler rod in order to obtain a homogeneous weld. The flux is used in order to hinder the formation of scale on the red hot copper as the scale prevents good metallic contact, and hence a solid joint, from being obtained.

Using these materials, it was demonstrated that with an hour's practice a welder could acquire the technique of copper welding and produce sound joints as easily as he could with ferrous materials.

NEW FINISH FOR ALUMINUM

A new, simple, and cheap method of giving aluminum a dead white finish was described by Leon McCulloch, research chemist of the Westinghouse Electric and Manufacturing Company, in a report to the American Electro-chemical Society.

The metal is boiled in milk of lime to which a little calcium sulfate is added. The new coating will be tested as a base upon which to apply paints and enamels to aluminum.—*Science Service.*

KONEL, A NEW METAL

Development of a new metal known as Konel, which is credited with being much stronger than other metals at high temperatures and which can be used extensively in the moving parts of internal combustion engines and other extremely hot places, has been announced by officials of the Westinghouse Electric and Manufacturing Company. The announcement followed the granting of foreign patent rights.

Originally developed by the Westinghouse Research Laboratories as a substitute for platinum in the manufacture of filaments for radio tubes, the new metal was discovered to be harder to forge than steel, and to be very tough at high temperatures, when most metals lose their strength. Engineers predict many uses for Konel. The new metal was created by Dr. E. F. Lowry, a graduate of Ohio State University.

Dr. Lowry said Konel had been subjected to exhaustive tests which revealed in turn the many valuable qualities it possessed.

"Almost without exception metals grow

softer and lose tensile strength as they undergo high heat," he said. "We have found that Konel, heated to 600 degrees, Centigrade, which is approximately 1100 degrees Fahrenheit, will withstand a pressure of 50,000 pounds to the square inch. Even further tests show Konel is tougher and harder when heated to 1800 degrees, Fahrenheit."

Dr. Lowry explained that Konel is a combination of cobalt and nickel from which it derives its name, and ferro-titanium.

As a substitute of platinum, Westinghouse officials are authority for the statement that Konel already is saving approximately 250,000 dollars monthly in the manufacture of radio tubes. Platinum costs approximately 180 dollars per ounce, while the new substance costs only a few dollars a pound. Life of Konel filaments is approximately 10 times longer than that of other filaments. Tubes with filaments made of the new metal are operated 175 degrees colder than tubes with platinum filaments but with the same emissions, thereby giving better reception results, research engineers say.

ELECTROCUTION

When a human being is subjected for a brief period to a considerable amount of voltage of either continuous or alternating electric circuits, changes are produced in the cells of his body. An engineer, aged 60, depressed because of ill health, made contact with an alternating current at 2200 volts potential. The current passed from his left hand to his left foot, and he may have been in contact for 20 minutes. Physicians in Baltimore made an investigation of the conditions of the cells of his body six hours after death. They found that the cells of the brain were swollen and had been badly injured by the current.

A man, 24 years of age, electrocuted for murder, was submitted to a voltage of

2200 for two minutes. When his brain was examined after death the same type of changes were found.

Rats were then electrocuted and real injuries were found in the nerve cells of the brain and spinal cord. Some of the greatest changes took place in the nerve centers in that portion of the brain which controls the breathing. If the shock is slight, the interference with the breathing is temporary and it is possible by the use of artificial respiration to bring about recovery. If the shock is continued for a long period of time the changes that occur are so definite and prompt that recovery is not possible.

THE YEAR IN MEDICAL SCIENCE

During the past year considerable progress has been made in many branches of medical science. Discoveries were made, which cleared up some of the puzzling features of former discoveries, opened new viewpoints and fields of exploration and, in many cases, completely upset or materially changed theories which had been in existence for many years or even centuries. Undoubtedly the most sensational of these discoveries, that of a remarkably effective remedy for insanity, was really made during the great war, but, for various reasons was not made known to the world in general until recently.

MALARIA A REMEDY FOR INSANITY

As far back as 1887, Dr. Wagner von Jauregg, a physician in Vienna, who was greatly interested in the study of the various forms and phases of insanity, began his efforts to find a cure for that supposedly hopeless disease. Guided by the well-known fact that during the great plagues, which had swept through Europe during the previous century, the startling discovery had been made, that many insane persons had become sane, he came to the conclusion that these miraculous cures had been effected by the fever, which was one of the invariable symptoms of the plagues. After experimenting for a number of years, with different fever producing substances, he finally came to the conclusion, that the best and simplest method of producing fever in a patient would be to inoculate him with malaria germs. At first he used mosquitoes for that purpose, but later he used the blood of otherwise healthy persons suffering from malaria.

Then came the great war with its tremendous suffering. In 1917 Vienna was filled with sick and wounded soldiers and the physicians and surgeons were overburdened with work. Among the men who had been sent back from the front were a great many who, besides having been wounded or having contracted some sickness, had also lost their mind. Dr. von Jauregg tried out his theory on some of the hopeless cases of insanity and inoculated them with malaria germs. The first patient, a soldier suffering from general

paresis, which would have caused his death in a short time, was inoculated and, almost immediately showed marked improvement. Two years later he had almost completely recovered. Dr. von Jauregg inoculated nine insane patients during those two years and all of them showed more or less improvement.

Beginning with 1919, Dr. von Jauregg, encouraged by this success, continued to use his treatment on a much larger scale. Since then between two and three thousand insane patients have been inoculated with malaria in his clinic with almost miraculous success. But that was not all.

In 1922 Professor Weygandt, director of an insane asylum in Hamburg, Germany, visited the United States and delivered in New York a lecture on the von Jauregg treatment of insanity cases, which at that time was almost entirely unknown in this country. Dr. William Alanson White, director of the St. Elizabeth Hospital for the Insane in Washington, D. C., which is conducted by the government, attended that lecture and, after a conference with Dr. Weygandt decided to try out that treatment at the government's hospital in Washington.

Since then the treatment has been used not only at the Washington insane hospital, but by various insanity specialists in different parts of the United States and everywhere with the most remarkable success. In fully one-third of the cases the patients are completely cured and restored to a normal mental condition, while another third of the patients are greatly improved.

Since then a thorough study of the whole subject has been made and the conclusion has been reached, that it is the blood heat produced by the malaria fever, which kills the micro-organisms causing paresis and makes it possible for a large percentage of the insane patients to regain a normal condition, unless the disease has already caused too serious and deep seated damage. As the treatment by inoculation with the germs of malaria is connected with considerable difficulties and sometimes leads to undesirable complications, an effort has lately been made, to find another,

less complicated method of destroying the germs of paresis. Various methods have been tried and it is now believed, that, before long, high-current vacuum tubes, developed by the General Electric research laboratories at Schenectady, will take the place of malaria inoculations. It is believed that the treatment with the aid of these tubes will not only be easier to control, but that it will also prove more effective in many cases.

FIGHTING OSTEOMYELITIS WITH MAGGOTS

One of the few good things the late war has produced in medical science, which was incidentally made during the war, has since then proved to be of the greatest value to thousands of the war victims and others who had suffered fractures or other bone injuries. It was the remarkable discovery, that osteomyelitis, or inflammation of the bone marrow, a disastrous disease, frequently developing in injured bones, could in most cases be prevented and even cured by allowing maggots, the larvae of the domestic fly, to take care of the injured bones and keep them free from the parasitic micro-organisms which produce osteomyelitis.

This important discovery was made during the war by Dr. William S. Baer, chief of the orthopedic section of the "Second Army" of the A. E. F., who is now connected with Johns Hopkins Hospital in Baltimore. During his activity as surgeon on the battlefields of France he made the puzzling observation, that soldiers who had been freshly wounded and who had been treated by modern antiseptic methods, frequently developed osteomyelitis, while other soldiers, who had been lying on the battlefield for a long time, before they were taken to the lazareth, and whose wounds were found to be infested with maggots, only rarely developed that disease.

After the close of the war, Dr. Baer returned to Johns Hopkins Hospital. One day, while reading a book, he found in it an account, that in ancient times maggots were used to cleanse the wounds of patients whose bones had been fractured. He remembered his strange experiences during the war and decided to investigate the matter. He began to raise maggots from the eggs of domestic flies in his laboratory and then tried the maggot

treatment on guinea pigs with broken bones. The wounds healed without the development of osteomyelitis. He tried this experiment many times on animals, always with the same satisfactory result.

Finally he ventured to try the maggot treatment on a severely injured man, whose case was considered hopeless and, to everyone's surprise, the man recovered. Greatly encouraged, Dr. Baer tried the treatment on other patients and soon he had a record of 120 successful cases, among them one man, who had undergone seventy-nine unsuccessful operations, but was completely cured by the maggot method.

The importance of this discovery may be judged by the fact, that there are in this country about 10,000 war veterans who are suffering from osteomyelitis; that in 1927 that disease caused the death of 1,240 patients and that the frequency of cases among civilians, thousands of whom are already suffering from that disease, increases from year to year as the result of automobile and other accidents in which bones are fractured.

Plans have already been arranged to have a number of bone specialists from Mount Alto Veterans Hospital to study the maggot treatment under the direction of Dr. Baer, with the hope to make it available to the large number of war veterans suffering from osteomyelitis.

PAINTING THE ARTERIES, THE NEW MEDICAL ART

When, a comparatively few years ago, Dr. Eugene Steinach, after a long series of experiments on animals and a few scientists of advanced age, informed the scientific world of the method discovered and developed by him to produce in human beings and in animals of the mammalian branch of the vertebrates, after they had reached an advanced age, a more or less pronounced rejuvenation and increase of vitality, he created a profound sensation throughout the world. His method consisted, briefly stated, in severing the sympathetic nerves around the seminal duct and was based on the theory that the deflected sexual force would be reabsorbed by the organism, producing a certain degree of rejuvenation.

A few years ago, Dr. Karl Doppler, another Viennese physician, who had made

a careful study of Dr. Steinach's rejuvenation method, had come to the conclusion, that it was not based upon a perfectly correct theory. After numerous experiments on animals, mostly rabbits and dogs, Dr. Doppler reached the conclusion, that the constriction of the arteries in old age was due to the hypertonic effect of the sympathetic nerves and that the elimination of that restricting factor would make a better blood supply possible to the various organs, thus producing rejuvenation.

At first, Dr. Doppler used, like Dr. Steinach, the surgical method for destroying the sympathetic nerves. Later, however, he found, that the same effect could be obtained in a much safer way, by painting the arteries with a 7.5 per cent solution of phenol-isophenol in water. In the course of his experiments and tests, Dr. Doppler operated on the arteries in various parts of the body and collected much valuable information. He found that the most satisfactory general results could be obtained by treating the arteries in the pelvic region, because it increased the blood supply to the endocrine glands and also benefited the heart, brain, kidneys and skin, thus producing a marked rejuvenating effect upon the whole body.

In the comparatively short time since he began to apply his rejuvenating method on aged human beings, Dr. Doppler has already treated more than 1,200 cases with remarkably good results of a general character, which mean a true rejuvenation of the whole body.

THE WAR AGAINST CANCER

The more medical science learns about cancer, the more interesting does the problem become which that dreadful disease presents. Although the general public is by no means kept in ignorance about cancer, its dangerous character, its prevalence throughout the world and the persistent efforts of scientists to learn the truth about its causes, its pathology and systematic effect and to find, if possible, some method of preventing or curing the disease, only few people realize the seriousness and vital importance of the subject.

It may truthfully be said, that cancer is the greatest scourge among all diseases the human race has ever known. During

the past year more than 115,000 persons in the United States alone died of cancer, more than 7000 of them in the City of New York. In both cases the figures given are undoubtedly too low, because in a large number of cases the cause of death had, intentionally or through ignorance, been diagnosed incorrectly.

Of these cases 38 per cent were due to cancer of the stomach, 9 per cent to cancer of the breast, 3 per cent to cancer of the skin and 14 per cent to cancer of the female genital organs. Cancer occasionally attacks young persons, but in most cases develops in individuals who have passed their 40th year. One out of eight men, whose death occurs between their 45th and 70th year, and one in five of all women who die between their 45th and their 65th year, die of cancer.

During the last fifteen or twenty years a great deal of study and research has been devoted to cancer, but the results have been meager and mostly of an uncertain character. Up to the present time nothing that could be called a positive cure for cancer has been discovered, nor has it been possible to find any solution of the problems concerning the actual causes and the physiological and other effects of cancer. But, the diligent researches by scores of investigators in all parts of the world have not been entirely fruitless during the past year. A number of important discoveries were made, which, although they do not solve the cancer problem, may eventually lead to its final solution.

Two eminent surgeons, Dr. Walter Bernard Coffey and Dr. John D. Humber, who had been carrying on their research work at the Southern Pacific General Hospital in San Francisco, Calif., for several years, made the interesting discovery, that an extract from a certain portion of the cortical region of the supra-renal or adrenal gland of a sheep, if injected into the body of an animal or human being suffering from malignant cancer, would destroy the tissues of the diseased parts.

The extract is not injected into the cancer area, but into the normal tissue, far away from the seat of the cancer. It has no irritating or harmful effect on the healthy tissue and produces no general constitutional disturbance, but kills the

malignant tissue and causes it to slough off. It requires more or less time for the system to rid itself of the dead cancer tissue, but in the meantime no toxic effect is produced.

The two discoverers of that treatment are of the opinion that cancer is a systemic disease which is caused by the disturbance in the body of the balance of the physical system. The cortical extract acts as a stabilizer, by restoring the normal circulation by means of the hormones and chalone produced by the various glands, re-establishing the normal equilibrium and, at the same time, eliminating the diseased, abnormal tissues which had developed because of the weakening of the growth-regulating power of the respective glands.

The two doctors had been studying the nature and treatment of another disease, angina pectoris, before they took up the study of the cancer problem. It was during these earlier studies, that they developed and used the treatment by injecting the cortical extract, which proved highly successful in every case. It was in 1926, when they first tried out the new treatment for angina pectoris. One of the patients they treated was also suffering from malignant cancer. They observed, that after the first injections not only the angina disappeared, but the cancer tissue began to die. They continued the treatment and finally the cancer was entirely removed and the patient was restored to a normal condition. That experience confirmed them in their belief, that cancer is a systemic disease.

The two doctors continued their experiments and studies, which invariably seemed to confirm the correctness of their theory that cancer is a systemic disease, but they were not yet prepared to proclaim to the scientific world their discovery as a cure of cancer, although it had proved to be effective in cases of carcinomas and sarcomas of every kind. It was only due to the urgent requests of a number of prominent scientists, who had learned about the discovery, that Drs. Coffey and Humber consented to submit an exceedingly modest report to the meeting of the Society of Pathologists held in San Francisco in the early part of 1930. They admitted, that further research would be necessary to find out just in which types of cancer and at which stages

of the disease this treatment would be most effective.

At the present time nothing definite is known about the primary cause or causes of cancer. Many theories have been proposed, but none of them has been supported by sufficient evidence to become generally accepted. About three years ago, two British scientists, W. E. Gye and J. E. Barnard, announced to the scientific world, that they had discovered a virus which they found to be the primary cause of cancer, but since then investigations by other scientists have brought out facts, which do not support the virus theory, which since then has been abandoned by nearly all cancer experts.

Another theory was advanced more recently by Dr. James B. Murphy of New York, who is the head of one of the divisions of the Rockefeller Institute. At the Cancer Conference in London he delivered an address, in which he stated that after sixteen years of research he had reached the conclusion that cancer was not caused by a virus, but by a ferment, the exact nature of which he had not yet been able to ascertain. There was no doubt in his mind, however, that the ferment causing the cancer was developed in the organism and produced the disease purely by chemical action not in an indirect way, by means of the living organisms, which a virus would naturally contain.

Many leading physicians are greatly impressed with Dr. Murphy's new theory and consider it of great importance. If, as Dr. Murphy is convinced, the substance which enabled him to produce cancer in various animals, does actually contain no living organisms, it cannot be considered a virus. But, if that is the case, it would completely upset the virus theory and, logically speak in favor of Dr. Murphy's ferment theory. A number of noted scientists are now carefully studying the matter to verify the data upon which this new theory is based.

Another recent discovery, which may have an important bearing on the solution of the cancer problem, was reported to the French Academy of Medicine by Pierre Delbet, one of the most noted surgeons of France. Delbet had for fifteen years made a careful study of the role which Magnesium, one of the light metals, played in

biology, had made extensive tests and collected a great deal of statistical and analytical material, which led him to the conclusion, that various abnormal conditions may or do develop in human or animal organisms which suffer from a deficiency of magnesium in their food. By his experiments he found among many other interesting facts that deficiency of magnesium in the system, if not the cause of cancer, was undoubtedly a powerful agent in aiding the development of the disease.

Doctor Delbet began to give to all patients suffering from cancer liberal doses of the halogen salts of magnesium before he operated on them or as a prophylactic before the cancer had passed the initial stage of its development. In all cases he observed that the increase of the magnesium in the system had a remarkably beneficial effect even in serious cases which required operations.

His theory, that deficiency of magnesium in the human system has much to do with the development of cancer cases, is still new and tentative, but a large mass of information already gathered in all parts of the world seems strongly to support it. For instance, a comparison of the maps of different countries, showing the distribution of magnesium ores, with maps of the same countries showing the distribution of cancer cases, has shown that invariably the largest number of cancer cases was to be found in regions where no or very little magnesium ore could be found. As water and vegetable foodstuffs, including grains, constitute the principal sources of magnesium for human beings and as these plants, if growing in regions where no magnesium, or merely traces of it are contained in the soil, naturally show a marked deficiency, it seems logical to draw the conclusion that the large number of cancer cases in such magnesium-poor regions is due to the insufficient supply of that metal.

Another striking example, which illustrates the importance of a sufficient magnesium supply, is furnished by statistics about the occupational distribution of cancer cases. It was found that cancer is extremely rare among the employees in breweries. An analysis has shown, that even the poorest grades of beer contain at least three times as much magnesium as

the best water. Considering the fact, that fanatical prohibitionists are not likely to be found among brewery workers, it is quite possible, that the liberal consumption of beer, rich in magnesium, adequately protects them from cancer.

Particularly interesting for the people in the United States and a few other countries, principally France, where all food-fads, no matter how silly and preposterous, seem to thrive beyond measure, should be the following data, which may show at least the possibility, that the enthusiastic adherence to certain foolish food-fads may in a large measure be responsible for the increase in the number of cancer cases in these countries since these fads found a strong foothold.

Among the large number of these senseless fads there are particularly two which deserve mention. One is the insistence on "free-running" table- and even kitchen-salt, the other is the almost universal refusal to use any but the finest, dazzling white flour for bread, rolls and other baked foodstuffs. The salt, formerly used, before the general adoption of the "pure salt" fad, contained 1.7 per cent of magnesium chloride and sulphate, the "free-running" salt contains less than 0.4 per cent.

Wheat, in the grain, contains 172.5 milligrams of magnesium per 100 grains, nearly all of it in the outer covering, which under the new milling process is almost entirely eliminated from the flour, which, in addition, is also bleached. The flour does not contain more than 67.7 mgr. per 100 grains in the coarser grades and 28.7 mgr. or even less in the "finest" grades, which are in general demand. It may be added, that by the elimination of the outer parts of the grain the wheat flour is practically robbed of its entire food value.

Dr. Delbet's theory has already won the approval and support of a number of scientists in France and elsewhere, who have expressed their conviction that the addition to the diet of the halogen salts of magnesium has a decided therapeutic effect in certain disorders of metabolism or nerve function and a prophylactic effect in cancer and in certain manifestations of senility. It is characteristic, that in a child calcium and magnesium salts are found in approximately equal quantities in the brain

and in certain glands, while in aged people most of the magnesium has disappeared. That is supposed to be the reason why cancer is rarely found in children or even in grownup persons under forty.

Radium has become an important factor in the treatment of cancer, but the supply available is extremely small. The total amount of radium in the world, available for medical purposes is estimated at less than 250 grams. That is by no means sufficient and determined efforts are being made to find additional sources of it. In the meantime investigations are being made to improve the X-ray equipments sufficiently so that they may replace the use of radium in cancer and other malignant diseases. Considerable progress has already been made, which promises better results in the future.

Quite recently Dr. Wood, the director of the Crocker Cancer Research Institute, made the sensational announcement that he had succeeded in growing cancer cells in a glass tube. He stated that there could be no doubt that they were really cancer cells, because they produced cancer after they had been experimentally transplanted into the bodies of rats. It is expected, that Dr. Wood's discovery will be a great aid in the study of cancer, by making it possible to make experiments with living cancer cells without the risk always connected with such experiments if performed on such cells still forming a part of the human organism.

Dr. Donald A. C. Butts, director of the Emery Laboratory of the Hahnemann Hospital in Philadelphia, recently made the announcement, that, in collaboration with Dr. Walter J. Crocker, chief pathologist at the laboratory, and Dr. J. W. Fink, in charge of the X-ray department of the hospital, he had succeeded in developing a dyestuff, which had a peculiar affinity for cancerous cells, which it stains quickly and completely, while it leaves the surrounding normal cells unstained.

Staining the cancer cells increases their resistance to X-rays, so that they may be more easily detected on an X-ray plate. This provides an accurate way for diagnosing cancer in its early stages and makes prompt surgical, radium or X-ray treatment possible. The dye, which belongs to the xanthene group and has a bright vermilion color, is injected directly into the

veins of patients in small, diluted doses. Experiments have thus far not yet revealed a satisfactory method for injecting the dye in sufficient quantities to stain large cancerous growths. Further experiments will be made with this interesting dyestuff, which has been designated as "E-47."

ON THE TRAIL OF TUBERCULOSIS

It seems that at last a point has been reached in the study of tuberculosis, from which a trail may lead to the final solution of the extremely complicated problem, which that disease has presented to science for many generations. Like everything else connected with tuberculosis, the latest discoveries in regard to its true nature are highly complicated and practically incomprehensible to the layman.

It was at the annual meeting of the American Association for the Advancement of Science, at Des Moines, Ia., that Dr. William Charles White, of the Federal Public Health Service, who is also chairman of a committee of the National Tuberculosis Association which is directing tuberculosis research work in twenty universities and research institutions, presented a report on the recently made discoveries.

Dr. White stated, that these highly important discoveries were the result of work done in the Sterling Laboratory at Yale and the Rockefeller Institute for Medical Research in New York.

He explained, that tuberculosis is a disease in which two living factors are concerned, one of the body cells known as the monocyte and the other the bacillus of tuberculosis. The latter grows in the former as a parasite. Each has a living chemistry of its own. When the two are combined as parasite and host, a new chemistry is set up, which results in the rapid growth of both and gives rise to what is known as tubercles, or tuberculosis.

It is possible, he stated, to isolate and grow in the test tube many strains of tubercle bacilli, human, bird and cow strains, and many others. Each of the disease-producing ones cause tubercles mainly in one animal family. By intricate chemical research the experts sought to find and identify the chemical substances in the different strains of bacilli responsi-

ble for the peculiar action of the tubercles on different animals.

The investigating scientists discovered different forms of sugar, fat and albumin which these different strains of bacilli make from the same food fluid. It was found that the principal difference was in the sugar produced by them.

The hope in all this work is, that some method may now be found, to interrupt the chemical union between the bacillus and the monocyte, so that the disease may be arrested, the sick person saved and the bacillus destroyed. The research is still being continued and it is hoped that before long more complete and definite results will be reached, which will make it possible to find a way to control this wild running bacillus.

How desirable it would be to reach the early fulfillment of this hope may be inferred from the fact, that during the year 1929 more than 1,500,000 persons in the city of New York alone were treated for tuberculosis.

INFLUENZA GERM REPORTED FOUND

After several years of research, aided by a group of thirteen coworkers, Dr. Isadore S. Falk, professor of hygiene and bacteriology at the University of Chicago, has reported that he had been successful in discovering and isolating the germ which causes influenza. According to his report, the influenza germ is of the pre-morphic streptococcus type, resembling a string of pearls, some smooth, some rough. The germs colonize in clumps, rough and smooth. The rough clumps are the more virulent, while the smooth ones, Dr. Falk believes, produce common colds of the sore throat type. The smooth germs are occasionally found in normal, healthy throats. After the germ had been isolated, Dr. Falk conducted a large number of experiments, which convinced him that it was really the influenza germ that had been discovered. He stated that the germ will not prove fatal in itself, but the disease which it causes weakens the patient often to such a degree, that he will succumb to the effects of other germs of greater virulence and toxicity. The research for the purpose of finding some vaccine or antitoxin which would make it possible to bring influenza and several malignant forms of colds under control,

is still continued at the laboratory of the University of Chicago, but no encouraging results have been reached so far.

BUBONIC PLAGUE SPREAD BY FLEAS

Ever since 1908, the State of Ecuador, South America, has been infested with the bubonic plague, which annually destroyed many lives in that republic. During that time, in Guayaquil, the principal port of that country alone, there have been over 7,200 cases. Last year Dr. John D. Long, special representative of the Pan-American Sanitary Bureau, and Dr. C. R. Eskey of the U. S. Public Health Service, went to Ecuador to study the disease and to co-operate with the Ecuador health authorities in fighting the disease.

During their stay in Ecuador they succeeded in making some valuable discoveries. In the mountain districts a new species of fleas was discovered, which is believed to be a carrier of the plague. It was also found that, in addition to the clinical types of the disease already known, there are two other types, not generally known heretofore. One of them is known in Ecuador as *Viruela pestosa* and represents the septicemic form of the disease, characterized by an eruption similar to chicken-pox, where the vesicles were found to be full of plague germs, making the disease highly contagious. The other new clinical type is known as *Angina pestosa*, which is characterized by a violent form of tonsilitis and pharyngitis and is equally contagious as influenza. It was found that in some outbreaks as many as 30 per cent of the cases were of one or the other of these new types.

A determined war against rats and fleas has been organized, which are the principal carriers of the plague germs in the coastal districts, while in the interior, particularly in the mountain districts, the disease is in most cases spread by Indians and other inhabitants who have become infected, or who carried infected fleas in their clothing.

THE FIGHT AGAINST POLYOMYELITIS

Polyomyelitis, better known under the name of Infantile Paralysis, is a much dreaded contagious disease, which at times becomes epidemic and which even if it does not cause the death of the patient, in

most cases leaves behind it some more or less serious weakness, paralysis or other defect, which in most cases cannot be cured or even much improved.

Very little is known about the primary cause of the disease, although there seems to be reason to believe that it is caused by some invisible germ which may be communicated from one individual to another by the secretions of the mucous membranes of mouth and nose. The disease in its early stage is rather difficult to diagnose by its first symptoms, fever, nausea and headache, because practically the same symptoms may be observed at the beginning of many other diseases of an entirely different character. Only experienced physicians are able to recognize the differences in the symptoms. After a short time the neck of the patient may stiffen or an arm or leg may become flabby and relaxed until at last it becomes completely paralyzed.

The difficulty of promptly recognizing the first symptoms is a very unfortunate feature, because only then is it possible by prompt and proper treatment to influence the course of the disease and, at least to some degree, mitigate its results.

Up to the present time the combined results of all the research work concerning this disease have not yet led to the discovery of a satisfactory method of curing it or for preventing it by immunization. It is true, a convalescent serum, taken from the blood of recovered patients, has been prepared and is now used to counteract the virus when injected, but it is only effective if injected before the disease has progressed beyond its earliest stages.

NEW REMEDY FOR RICKETS FOUND

After a thorough research extending over a period of two years, Dr. Lloyd K. Riggs, director of research at the Rutgers University College of Pharmacy, at Newark, N. J., has reported his discovery that a dry powder, obtained by the careful evaporation of whey has been found to be of great value in the treatment and cure of rickets and, possibly, also of tuberculosis. Especially in the treatment of children, suffering from rickets, Dr. Riggs believes that whey powder is superior to a diet rich in vitamin D, because the whey powder contains in balanced

proportion the mineral elements essential to normal bone development and the absorption of which is materially aided by the milk sugar combined with it.

Dr. Riggs has also pointed out other advantages of the use of whey powder over milk and other sources of vitamin D in the treatment of rickets and tuberculosis, among others the possibility of its employment in cases of milk intolerance of the patients. Experiments and researches concerning the effects of whey powder in cases of rickets and tuberculosis will be continued to definitely establish its value as a curative and prophylactic agent in these diseases. Dr. Riggs has pointed out another economic factor in favor of whey powder by calling attention to the fact that it means the utilization of the enormous quantities of whey which are poured into the sewers every day, because heretofore they were considered to be without any value.

Dr. George H. Maughan and Dr. J. A. Dye, of the department of physiology, Cornell University, who have conducted an extensive study of the preventive and curative effect of ultra-violet rays in the case of rickets, have recently submitted a detailed report about their findings. They stated that exposure to ultra-violet rays prevents or cures a number of diseases, among them rickets. But, in order to be effective, the rays must penetrate the outer skin and reach the blood vessels and the nerves just beneath the epidermis.

"Prevention will ultimately prove more important than cure of disease," they said among other things. . . . "Some diseases, like tuberculosis, seem to respond better to sunlight than to artificial radiations. The disease of rickets, however, is affected very well by the artificial radiations."

By artificial radiations are meant the ultra-violet rays emitted by the quartz mercury arc lamp and similar apparatus.

According to the two scientists, the ultra-violet rays must go through the epidermis and reach the blood and nerves just beneath the skin, to be beneficial. They estimate the average thickness of the skin at about one millimeter, while the capillaries in the papillae of the skin are about two to five millimeters below the surface of the skin.

They also found, that less exposure is required to prevent than to cure a disease.

THE PUZZLE OF ENCEPHALITIS

When the average person speaks of encephalitis, it is difficult to guess what he really means. The reason of this uncertainty lies in the fact that various circumstances have caused a confusion in terminology, which the layman is unable to disentangle. Encephalitis, generally speaking, means inflammation of the brain, but really no specific disease. Encephalitis lethargica is an abnormal brain condition which produces a deterioration of the brain, which manifests itself by great sleepiness and which, for that reason, is often called "sleeping sickness." But sleeping sickness is really another disease, the scientific name of which is trypanosomiasis and which is an endemic tropical disease, produced by the presence in the blood and the cerebro spinal fluid of a certain protozoon, known as *trypanosoma gambiense*, introduced into the organism of the victim through the bite of a certain species of tsetse flies, which is known by the scientific name of *glossina palpalis*.

But that is not all. There is another encephalitis, which is known to science by the name of encephalomyelitis, and finally a comparatively little known recently identified disease, which in England was given the provisional name of post-vaccinal encephalitis and which is a brain disease which has developed in a number of individuals in England and occasionally elsewhere, after they had been vaccinated to protect them against various infectious diseases, and sometimes after they had just passed through an attack of influenza, measles, or whooping cough.

Post-vaccinal encephalitis is one of the diseases which only in recent years have been observed and identified as a specific disease and up to the present time very little is known about its causes and how it can be prevented or cured. It is not even definitely known, whether it is really a specific disease or merely an unexplained complication, resulting from a combination of latent conditions in the individual. There are many theories concerning its origin. While some scientists believe, that it is caused by the vaccine virus itself, others are of the opinion that it is produced by the exciting of some still unknown infectious agent, existing either in the virus or in the vaccinated individual. No method has as yet been discovered to

prevent or counteract the disease, but in view of the fact, that post-vaccinal encephalitis develops only rarely in children during the first year of their life, it is believed to be advisable to perform primary vaccinations on children during the first year of their life instead of later.

Another kind of encephalitis, now known as "epidemic encephalitis," has recently come in the foreground. It was as it recognized as a specific disease, unknown before 1915 and not until 1917. Since then it has not only caused a great loss of lives in the United States and many of the European countries, but also great misery and suffering among those who survived the attacks of the disease.

Epidemic encephalitis has been carefully studied during the few years since its identification, but very little is known so far about its cause and pathology. Several theories have been developed concerning the cause and the nature of the disease, but none has been generally accepted so far. The most recent theory is, that the disease is caused by a filtrable virus, but no satisfactory evidence for the correctness of this theory has been found so far.

A NEW AND EFFECTIVE WEAPON AGAINST MEASLES

Measles are the most prevalent of the diseases of children and for many years efforts were made to find some effective method of controlling them. About thirty years ago, when serum treatments came into vogue, some doctor succeeded in obtaining a serum from the blood of persons who were convalescing from measles. That serum proved to some degree effective when inoculated into children, but its effect did not last long.

In 1920, Dr. Degkwitz, of the University of Greifswald, Germany, after two years of careful experimental tests, informed the medical profession of his discovery, that a small quantity of blood from either parent who has had measles, if injected into the muscle tissue of the child, will have two most desirable effects. In the first place, if the child so treated should contract the disease, it will only be in a very mild form. In the second place, such an attack of measles would make the individual immune against that disease for the rest of its life. This treat-

ment has been tried out in many thousand cases by the discoverer himself and numerous physicians in many parts of the world and was found to be highly effective. It is now also used in the United States with great success.

Medical authorities are of the opinion that, even if it should be possible, to make all children completely immune against measles, it would be unwise to do so, because that disease is exceptionally malignant, when it breaks out again in a region where the inhabitants have long been immune. It was first introduced in the Sandwich Islands in 1775 and in four months killed 40,000 persons out of a population of 150,000. When it was introduced in the Fiji Islands, in 1874, it killed twenty per cent of the population. From these experiences the conclusion has been drawn, that, if by the use of some method the development of measles should be completely prevented, it would lead to the gradual building up of a large number of non-immunes, who would be wiped out, in case, by some chance, the disease should again be introduced.

PSITTACOSIS GERM REPORTED FOUND

Psittacosis, or "parrot fever" is one of the most recent additions to the already long list of infectious diseases dangerous to the human race. It has undoubtedly existed for a long time before it was identified as a specific disease. Since then a considerable number of cases of that disease has been reported from various countries in Europe, as well as in South America and in the United States. For several years, in spite of the most diligent research by experts, the primary cause of the malignant disease could not be discovered and finally the conclusion was reached, that the causative agent undoubtedly belonged to the filtrable virus type.

Since then, however, a French investigator claimed to have isolated the bacterium producing psittacosis and Dr. Lloyd Arnold, director of the Chicago laboratories of the Illinois Board of Health confirmed the discovery of the French scientist by reporting that he also had succeeded in isolating the same bacterium which he found to be of an extremely virulent type. One drop of a culture killed a rabbit inoculated with it within ten hours.

NEW DATA ABOUT THE VITAMINS

Nearly in all cases of important discoveries the first results are incomplete and sometimes misleading, because their novelty makes it difficult to understand them, which often leads to misinterpretations. The discovery of the vitamins was no exception in that respect. At first the real meaning and the functions of the vitamins were not clearly understood and the natural consequence was, that many theories were built concerning them, which were found to be incorrect and absurd after the subject had been more thoroughly studied. Yet, even now, the problem is not completely solved and from time to time new theories are advanced, which lack a logical foundation and are soon discarded.

During the past year the science of the vitamins has been enriched by several interesting discoveries. Two American investigators, Evans and Burr, reported the discovery of a new, the fifth member of the vitamin group, which they named "Vitamin E." It is the anti-sterility vitamin, which is principally contained in various vegetable oils. The two investigators experimented principally with oils extracted from wheat germs and cotton seed and obtained by their use remarkable results in numerous experiments.

Their investigation showed, that these oils, containing the vitamin E, possess a remarkable power to resist heat and can even be distilled in vacuo at a temperature of 200° Centigrade, without losing their effectiveness as an agent against sterility. Neither in acid nor in alkaline solution is it destroyed by oxygen. Definite information concerning the chemical structure of the vitamin and how it produces its effect upon the generative organs is still lacking, but it is believed that in the female it materially influences the iron metabolism. Up to the present time the experiments with vitamin E have been confined to animals and it is not yet known, whether it will prove equally effective in human beings. The research work is still continued and may lead to additional important facts in the near future.

There are two extremely serious diseases, which have been known for a long time, but until recently have always been considered incurable and hopeless, hemophilia or "bleeder's disease" and pernicious anemia. Now there seems hope, that

before long, it will be possible to cure or at least relieve both these diseases.

Only a few years ago, Felipe Llopis, a Spanish scientist, reported the discovery, that hemophilia could be favorably influenced and the bleeding symptom practically eliminated by a plentiful supply of the four vitamins A, B, C, and D. Since then, the subject has been taken up by the medical profession in the United States, Germany and other countries and it was found that the treatment suggested by Llopis proved very successful in nearly every case.

Three years ago, pernicious anemia was considered an absolutely hopeless and fatal disease. Since then, however, two American scientists, Minot and Murphy, have discovered that this extremely serious disease could be greatly benefited if not entirely cured, by feeding the patient with a diet containing liberal quantities of scraped liver and liver juice. As liver is rich in vitamins A, B and C, the scientists are now trying to ascertain, whether or not it would be possible to produce the same favorable effect by giving the patient

the same kind of tablets, which Dr. Llopis prescribed for hemophilia and which contain a mixture of the vitamins A, B, C and D, together with calcium phosphate and lactose. That is important, because many patients have a strong inborn aversion against liver.

Ever since the discovery of the vitamins it was believed, even by experts, that the boiling of milk completely destroyed its value as a source of the important vitamin C. Recently, however, Doctors E. W. Schwartz, F. J. Murphy and R. M. Hand of the Mellon Institute of Industrial Research, University of Pittsburgh, after a careful investigation established the fact that only 20 per cent of vitamin C was destroyed in three quarts of milk that had been boiled lightly for five minutes.

It was also found, that fresh milk loses its vitamin C power when it is kept in copper or other oxidizable metal containers. Aluminum, however, has no such destructive effect on the vitamin content of milk. Glass containers are the most preferable. —*Ernest Welleck.*

ACCIDENTAL DEATHS IN 1929

An increase of 3,000 in motor vehicle fatalities in the United States during the year 1929 brought the total accidental deaths from all causes in the nation up to 97,000 for the year, according to the National Safety Council. The 1928 figures for all classes of accidental deaths was 95,086.

While the total of deaths through accidents for the year increased by slightly less than 2,000, deaths from automobiles alone reached a new high of 31,000, as against 28,000 for 1928.

These figures tend to show, the report points out, that motor vehicle fatalities alone are on the increase, other types of accidental deaths showing a gradual decline.

Accidents to children are increasing far

less rapidly than those to adult persons.

Accidents in homes were responsible for the taking of 23,000 lives, while still another 20,000 persons lost their lives in public accidents in which the automobile was not involved.

The principal cause of home accidents was falls, 9,200 persons losing their lives in this manner.

Burns, scalds and explosions accounted for the next largest number of home fatalities, while asphyxiation and suffocation were the next most frequent causes. Poisoning from carbon monoxide gas, caused by careless or ignorant persons permitting their auto motors to run in closed garages, was responsible for a considerable number of the asphyxiation deaths.—*N. Y. Times.*

BODY CONTAINS MANY MINERALS

The human heart contains copper, aluminum and a little silver; the brain is especially rich in tin; the lungs contain practically the body's total supply of the rare metal named titanium; nearly all of the cobalt and nickel which the body contains are concentrated in the pancreas, the gland which produces insulin and makes it possible for people to eat sugar as food.

Such are some of the conclusions reported recently to the Academy of Sciences in Paris by P. Dutoit and Christian Zbinden, who have tested by the extremely delicate methods of the spectroscope which metallic elements are present in the ashes from a half hundred or more human organs obtained from post-mortems in Parisian hospitals.

This is not the first time that metallic elements have been discovered in human tissues, although the recent French investigations are probably the most comprehensive ever made. More and more is the science of physiology confronted with the problem of deciding what are the duties of these mysterious accumulations of metallic elements in the various mechanisms of the body.

Were ordinary chemical analysis the only tool of the investigators the presence of these elements probably never would have been discovered. The tin in the brain, for example exists only as a minute fraction of 1 per cent., probably impossible to detect by ordinary chemical tests even in the ashes of many brains put together. However, recent developments of the spectroscope solve this problem of finding tiny amounts of strange metals anywhere.

DETECTS METALS IN TINY QUANTITIES

The atoms of each element emit, physicists have discovered, definite wave lengths of light or ultraviolet rays whenever these atoms are highly heated or electrified. The spectroscope sorts out these rays, a spectroscopic photograph carrying what is really the signature of all of the atoms which are present.

By a recently developed apparatus, for example, it is possible to lay down a supposed silver coin in front of a simple spectroscope, pass a tiny electric spark be-

tween this coin and another terminal and say definitely whether copper, tin, lead or any other metals are present in the silver. Copper, of course, is a normal thing in silver coins.

Any quantity of lead is abnormal. Counterfeit lead quarters, for example, disclose their real nature instantly to this new instrument. Counterfeit gold or platinum for jewelry or dental purposes is equally powerless to continue its disguise.

To apply these new and delicate methods for the detection of tiny traces of metals, the French investigators of the human organs first prepared ashes of the organs. A human heart, for example, was burnt in a furnace much as the whole body is reduced to ashes in a crematorium. These ashes contain, investigators have discovered, nearly all of the metals present in the original organ. Almost any organ, for example, gives ashes containing a substantial percentage of iron, since iron is present always in blood because of the fact that the red coloring matter called hemoglobin, of that fluid, is an iron compound.

COPPER AND SILVER COMMONEST IN BODY

To detect the traces of other metals like silver or copper or tin, MM. Dutoit and Zbinden then placed the pinch of ashes from a heart or brain in an apparatus producing powerful electric sparks. Driven through the ashy dust, these sparks vaporized not only the iron and other ordinary metallic elements but also any traces of tin, silver or still rarer metals which had been present in the original organ. Observed or photographed through the spectroscope each of these atoms wrote its visible signature for the investigators to decipher.

With the exception of iron, which is present everywhere in the body, copper and silver are perhaps the most widespread metals in human organs. Traces of both are contained in the heart, the kidneys, the spleen, the liver and the majority of the various glands. Outside of the brain, the chief lurking places of tin in the body seem to be the spleen and the thyroid gland in the neck, the gland which occasionally becomes diseased and enlarges to form a goiter.

This thyroid gland, indeed, seems to act as a special catch-all for metallic elements. Silver, copper, lead, tin and zinc are found plentifully, the French investigators report, in the tissues of the thyroid. Another relatively rare element although not a metallic one, the element iodine, is already known to be plentiful in the thyroid gland and to be necessary for the proper working of that organ. This is why it is now the practice of physicians to feed small quantities of iodine to patients believed to be in danger of developing goiter or other thyroid disease.

Aluminum, one of the most widespread elements in nature and which must be absorbed in considerable quantities all the time by the body's digestive system, is found chiefly, the French investigators report, in the lungs, the kidneys and the two glands close to the kidneys called the adrenal glands. A trace of aluminum is found also in the heart.

Curiously, the heart seems to contain no zinc, although that element is present in notable amounts in the thyroid gland and even more so in the sex glands. Chromium, the metal recently become important for plating iron particles and other metallic objects, is another widespread bodily metal, somewhat more common, apparently, in the thyroid gland and in the spleen than in other organs.

Most notable of all the French results is, physiologists agree, the apparent concentration of different metals in specific organs. Virtually all of the bodily cobalt and nickel, for example, is found in the pancreas. Virtually all of the titanium occurs in the lungs. Copper is especially plentiful in the liver.

Probably these metallic concentrations are not accidental. Prof. Frederick B.

Flinn of Columbia has discovered, for example, that copper appears to have some function in the human body, with some relation not yet fully understood to the formation of the blood. This result is confirmed by work of other investigators. Another distinguished French chemist, M. Gabriel Bertrand, has shown that the nickel and cobalt in the pancreas probably have intimate and important relations to the production of insulin.

DISCOVERY MAY AFFECT MEDICINE

Fifteen years ago, in the laboratories of Johns Hopkins University, Prof. Burton E. Livingston, Dr. Sam F. Trelease and I found that very small traces of copper and several other metals added to a food solution in which wheat plants were growing, had the effect of stimulating markedly the growth of these plants.

Dr. Oswald Schreiner of the United States Department of Agriculture has made similar investigations and has suggested that possibly some of these metallic elements might be used as mere traces in fertilizers for the practical benefit of agriculture.

There are many other facts to reinforce the suggestion that minute traces of metals have much more to do with the operation of living matter than previous generations of physiologists have been inclined to believe. Modern knowledge of vitamins makes clear that tiny traces of specific chemical substances may mean health or illness if not actually life or death for living creatures. Perhaps traces of metals like the silver in the heart, the copper in the liver or the tin in the brain, may be equally important. This is now what physiology must proceed to discover.—*Dr. E. E. Free in N. Y. World.*

METAL IN THE HUMAN BODY

Copper is normally in nearly all foods in appreciable quantities in the absence of adulteration. It is found in wheat, buckwheat, cocoa, crabs, eggs, cherries, nuts, all kinds of meat, milk, fish foods and vegetables. Liver and lentils particularly are high in copper. Copper is taken in daily with the foods we eat. A minute quantity is retained as a normal constituent of the body; the excess is excreted.

Within the last few years certain doctors have intimated that copper was injurious. However, the results of more recent research over several years by Dr. Frederick B. Flinn, Director of Industrial Hygiene, and Dr. William C. von Glahn, Associate Professor of Pathology, at the College of Physicians and Surgeons, Columbia University, New York, has apparently shown that copper in small amounts is not injurious.

These researches, conducted in the light of greater knowledge of medicine and with facilities not available in Pasteur's day, confirm his findings: "In regard to the toxicity of copper salts, it may be said it is almost impossible to take a dose large enough to produce death, both from their horrible taste and from the violent vomiting which they produce. In small quantities the taste is not perceptible, and the salts are not only tolerated but absorbed. Workers in copper are often completely saturated with the metal, but do not suffer from it. Experiments on animal and human subjects have never given a worse results than vomiting or a temporary fit of colic. Copper normally exists in the human body. It gains entrance from various foods and drinks in the absence of all adulteration. It accumulates to a certain extent but injury from this accumulation is unknown."

Drs. Flinn and von Glahn used rabbits and other animals, as well as human material obtained from autopsies. Their report, published by the *Journal of Experimental Medicine*, states that no serious effects were noted and that the animals fed copper were as healthy as, or healthier than, the control animals, which were not fed

copper. No liver lesions were detected and no cirrhosis of the liver apparent.

Normal human livers obtained from routine autopsies were examined, in addition to other specimens from workers in the copper industry. "It is interesting that the (copper) contents of the livers from workers in the copper industries was close to the minimum." These investigators examined the livers of numerous animals, all of which were found to contain copper, the amount varying with the species. Scientists have found on analysis that copper is always present in human milk and also in cows' milk. It is found in most insects and marine animals, and in many plants.

Dr. E. B. Hart and his associates conducting research at the University of Wisconsin announced recently to the American Society of Biological Chemists: "Copper may become acknowledged as one of the more essential requisites in human nutrition and livestock feeding." The Wisconsin experiments indicate that it exerts a great influence on anaemia in children who have been fed exclusively on milk. This malady in both rat and child is caused by a deficiency of hemoglobin in the blood stream.

The anaemic condition in the rats was not bettered until the milk diet was supplemented by giving them dried liver. It was subsequently found that this liver contained copper and that it was the copper in the liver and not the iron that was responsible for the cures. "Rats so anaemic that their days appeared to be numbered, recovered immediately and the hemoglobin in their blood was brought to normal." Anaemic persons were advised to eat liver because of its copper content. Judging from what has happened to the price of liver, that advice is being followed.

It is not yet known exactly what is the function of copper in plant and animal tissue. Hemoglobin may or may not contain copper. The copper may act merely as a catalyzer helping to produce the hemoglobin without itself being changed.—*William G. Schneider, Research Narrative No. 156, Williams & Wilkins Co.*

NEGRO INFANT MORTALITY

A report has recently been issued by the U. S. Public Health Service on a study based on negro and white infant mortality rates in the urban and rural areas of a group of Northern and Southern States, in urban and rural Maryland, and in four cities, viz., Richmond, Va.; Baltimore, Md.; Charleston, S. C., and New Orleans, La.

In every area studied, negro infant mortality rates were higher than the corresponding rates for white infants. This difference was most marked in the urban areas of the South. Negro infant mortality rates in the rural South, however, were nearer to those of the corresponding white infant mortality rates than in any other area. The lowest negro rates were found in the rural South and the highest in the Southern cities. On the whole, infant mortality among the negroes shows trends similar to those shown by infant death rates among the white populations of the same communities. In two cities, Baltimore and Richmond, negro infant mortality has declined more rapidly than that of the white population.

The study also discusses negro and white infant mortality from various causes in several of the Southern States of the birth-registration area.

Negro infant death rates are higher than the rates for white infants for every cause except four contagious diseases. The greatest excess of negro over white infant deaths was due to unknown and ill-defined diseases. Deaths from respiratory diseases, all forms of tuberculosis, and gastro-intestinal diseases were consider-

ably more frequent among negro than among white infants. Mortality among infants of both races is extremely high during the first month of life; white rates fall rapidly during successive months; negro rates also decrease, but the decline is not so sharp. The ratio of negro to white infant deaths is highest between the fifth and the tenth month. The excessively high rates which occur in both races during the first month are due for the most part to premature birth and congenital debility. Negro and white infant mortality from these causes are very much alike. The principal cause of the excess of negro over white infant deaths from the second to the tenth month is pneumonia. Deaths from diarrhea and enteritis are considerably more numerous among the negroes than among the whites.

Infant mortality from diarrhea and enteritis is on the decrease among both races in Maryland. The reduction in the number of deaths from this cause has been much more rapid during the past 10 years than before 1920. White rates fell somewhat more rapidly than negro. In Maryland, infant death rates from all forms of tuberculosis are considerably higher among the negro than among the white infants. The rates have declined much more rapidly among the white population. There is little improvement in the rates from diseases of early infancy in either race. There has been, on the whole, more reduction in the death rate from diarrhea and enteritis in urban than in rural areas. In the six Southern States studied, urban rates are higher than rural, except in Maryland.

NATURE PURIFIES POLLUTED WATER

In the study of the pollution of streams the United States Public Health Service has directed considerable attention to the operation of natural processes in the purification of polluted water, especially the agencies and methods utilized by Nature in this process. In this intensive study it has been found that pollution (sewage, non-poisonous industrial wastes, and similar polluting matter) when put into water, is immediately attacked by bacteria which are so small that at least two millions of them could rest comfortably, side by side, on the head of a common pin. These minute organisms find the pollutional material a satisfactory food and increase rapidly in numbers. By this feeding process, oxygen dissolved in the water is used up and the pollution is transformed into harmless bacterial bodies and by-products which are not putrescible.

At first it was believed that the bacteria, unassisted, could completely purify polluted water. This was found not to be the case, however. The bacteria multiply in the polluted water until a certain number of population is reached, the limiting number varying with the amount of pollution present. When the limiting population is reached, multiplication stops and the process of purification also stops, although considerable amounts of pollu-

tion may still be present. If the bacterial population of the water is reduced at this time, the multiplication and purification processes continue. To arrange for a continuous reduction of bacterial numbers, Nature, in her marvelous economic system, has provided some very small animals, called Protozoa, whose principal food appears to be bacteria. These bacteria-eaters, which are very much larger than bacteria, but yet so small that fifty of average size could lie on the head of a common pin, feed continuously on the bacteria and thereby prevent the bacterial population from ever reaching a limiting number.

In this manner Nature provides for the completion of the purification process, and the bacteria and the protozoa in the water decrease in numbers as the amount of food available for each decreases.

The addition of any poisonous substance to the polluted water may slow up or, if a sufficient amount be added, completely stop Nature's purification process, by killing off prematurely these industrious workmen.

A series of interesting papers describing the methods employed and the results obtained in these studies are being published in the Public Health Reports under the general heading of "Experimental Studies of Natural Purification in Polluted Waters."

FEDERAL CANCER SURVEY

The U. S. Public Health Service will be enabled to begin its cancer survey of the United States at once due to the insertion by the Senate of a \$100,000 item in the Second Deficiency bill to be passed before Congress adjourns.

The cancer survey was authorized by the Senate Commerce Committee and it will include:

An investigation of the researches being carried on with respect to control of cancer in various institutions in the United States and abroad.

An investigation of existing methods of treatment of cancer with view to determining and encouraging use of best methods of treatment to the exclusion of those that are worthless or fraudulent.

The ascertaining of best methods of increasing the number of physicians skilled

in the diagnosis and treatment of cancer.

The ascertaining of best means of educating the public with respect to the signs and symptoms of cancer in early stages in order to prevent neglect and delay in treatment.

The ascertaining of the extent to which provision now exists for furnishing optimum treatment for cancer for all sufferers, together with estimate of what would be needed to make this adequate and the cost thereof.

The collection of any other pertinent data to enable Congress to act advisedly in this matter.

Congress has indicated its willingness and desire to do all in the way of cancer appropriations and legislation which shall be recommended by the Surgeon General as a result of the pending survey.

ENDEMIC GOITER

The results of six years' study of endemic goiter, also known as simple goiter, by the United States Public Health Service are incorporated in a report recently issued. The conclusion is reached that this form of goiter, which is present to a considerable extent in certain parts of the United States, is simple in name only, for the causative factors concerned in its production are undoubtedly numerous, even complex. This bulletin, which contains a foreword by Dr. David Marine, eminent American authority on goiter, will prove of interest to physicians, public health officials, nurses, educators and others concerned with the prevention and treatment of goiter.

The goiter studies, conducted from headquarters located in Cincinnati, Ohio, were directed along three principal lines:

1. Studies of the distribution of simple goiter.

2. Studies of the causes and effects of simple goiter.

3. Dissemination of authentic information.

Thyroid surveys were made by the same officers of the Public Health Service in the States of Colorado, Connecticut, Massachusetts, Oregon, Tennessee, South Carolina, and in the City of Cincinnati, Ohio. As a result of these investigations it has been possible to distinguish variations in goiter incidence within individual States and to indicate the places in which

goiter prophylaxis is required. Graphic representations of characteristic incidence curves are shown.

The findings of several investigations, having for their purpose the determination of the causes and effects of simple goiter, are also set forth in the report. Thus, efforts were made to learn whether communicable diseases, routine physical exercise or potential foci of infection, such as may exist in decayed teeth and diseased tonsils, are responsible for endemic goiter. The effects of endemic goiter upon intelligence, physical growth and school attendance are indicated. Interesting accounts of the gross and microscopic anatomy, as well as the instructions for making thyroid surveys, with suggestions for interpreting and utilizing the information gathered, are a feature of the report.

The cause of simple goiter is considered in detail. There is also a critical consideration of the various prophylactic measures and their relative value. The importance of iodine prophylaxis during pregnancy has received particular emphasis. While suggestions are given for the appropriate treatment of endemic goiter the self administration of iodine, either for prophylaxis or treatment, is condemned.

The value of the report is enhanced by photographs of a number of thyroid-normal and thyroid-enlarged individuals, both in profile and full front view. Other illustrations show the topographic relations of the thyroid gland.

THROATS OF SWORD SWALLOWERS

Some French physicians have examined the throats of sword swallowers with X-rays and the esophagoscope, the American Medical Association has just reported. The doctors found that in these men the lining of the esophagus, which is the tube leading from throat to stomach, was slightly swollen and very red. However, it did not show any signs of recent or old injuries.

By means of the fluoroscope, which makes use of X-rays, the doctors were able to watch the sword being swallowed all the way into the esophagus. This performance, which seems to be most hazard-

ous, really is very simple and if it is done adroitly the performer is in no danger of injury, the doctors found.

Another interesting fact observed was that the sword swallowers breathed differently from most people. Their breathing was done exclusively by movement of the ribs, without any movement of the diaphragm. This was true of their normal breathing when they were not performing their act, as well as of the breathing while swallowing the sword. Evidently a special physiologic predisposition, either natural or acquired, is necessary for success in sword swallowing.—*Science Service.*

LEPERS IN THE UNITED STATES

That leprosy now exists in the United States and has existed here for a great many years is a truism which seldom occurs to the average person until newspaper headlines attract attention of a community to some unfortunate person who is afflicted with the disease. Then, after a few days' hysterical attention to the subject, the question again drops into temporary oblivion.

In some of the States, leprosy has long been a problem of importance because of its presence in neighborhoods populated by descendants of certain of the earlier settlers, and of the fact that its propagation there is due to factors not well understood. For lack of a better explanation, racial or family predisposition, local habits and customs, and the like, are ascribed as causes. In other States, particularly those with large seaports, cases of leprosy develop among immigrants who have been admitted with the disease in an early and undiagnosable form, and the disease has spread, slowly, to be sure, among the native population. A third source of infection is that found in our military and maritime population, in the soldier or seaman who has lived in an infected territory for a number of years, has contracted the disease, and has later returned to his native country.

Geographically, the Gulf Coast States are considered as the most important foci of leprosy in continental United States; for here is recognized indisputable evidence of the continued propagation of leprosy, and here the disease has existed for generations, having been sustained by contact with leprosy communities through commercial sources.

A conservative estimate of the prevalence of leprosy in continental United States places the number of cases at approximately 1,200. A reliable estimate of the number of lepers who have resided in the United States is well nigh impossible, and for many reasons. It is probable that, many times, leprosy has been confused with other diseases with which it has symptoms in common; furthermore, leprosy has not been consistently reported to health officials, and the public records must, of necessity, represent but a surface

scratching. Then, too, in many instances, physicians have hesitated to report known cases of leprosy because of the unwarranted hysteria that would have been provoked by the report of the presence of a case of leprosy in a neighborhood where no suitable facilities existed for isolation and treatment, and where the leper had been permitted and encouraged to move on. Sometimes this method of dealing with lepers has been most humiliating to the leper and disgraceful to the community.

Incredible though it may seem, leprosy, one of the oldest diseases of which authentic medical knowledge is available, has been throughout history one of the least understood and most maligned.

While it is undoubtedly true that leprosy is an infectious, slightly contagious disease of unknown means of transmission from person to person, and while untreated and uncared for lepers almost inevitably progress to repugnant pictures of suffering and mutilation, it has remained for the last few decades to allay, to some extent, the frank terror which the word "leprosy" strikes upon a neighborhood.

Until comparatively recent years, the aphorism "Once a leper, always a leper" was sufficient to quench all hope in the afflicted and to bring consternation to family, friends, and community. Within a generation, however, improved therapeutic measures and more concentrated and national consideration from scientists have led to the conclusion that the lot of a leper is not necessarily hopeless, and each year increasing numbers of patients are being discharged from leprosariums either as "cured," or are paroled as no longer a menace to public health.

As research has continued, a more nearly humane view is being taken of the relative danger of leprosy in a community. That some danger exists must be admitted; for "leprosy begets leprosy"; that the danger justifies the terror which sometimes pervades a neighborhood upon the public announcement of the discovery of a leper cannot be admitted.

Barely fifty years ago, the discovery of the causative agent of leprosy, the "leprosy bacillus," by the Norwegian scientist, G. Armauer Hansen, cleared the

way for removal, from the sufficiently evil name of leprosy, of a number of similar but essentially different diseases; and the diagnosis of leprosy today is rarely made, even by an experienced physician, until the leprosy bacillus has been found in the suspected patient. Leprosy as it is now recognized differs in no important respect from true leprosy of centuries past, save that by differentiation from unrelated diseases a clearer conception of the disease has been obtained.

The origin of leprosy in the United States has not been conclusively demonstrated. No evidence of its existence prior to the arrival of Columbus has been found in the North or South American continents. The disease appears to have manifested itself almost coincidentally with the early settlements and to have, in a measure, progressed with them.

Cartagena, a port of what is now the territory of the Republic of Colombia, was the center of the slave markets of the Spanish Main; conceivably, therefore, this port should soon have become a focus of leprosy on the continent, and it was in Cartagena that, early in the seventeenth century, the first leprosarium of the New World was established; the first leper of sufficient prominence to receive mention in the history of the New World, however, was Gonsalo Jimenez de Quesada, the founder of the city of Bogota, Colombia, who was declared a leper in 1573.

Similarly, New Orleans, which became an important center in slave traffic, also became an early focus of leprosy, and it is of interest that in 1778 the disease was considered of such importance as to require the construction of a special hospital for the exclusive care of leprosy patients. "There being a number of persons in the province afflicted with leprosy, the Cabildo erected a hospital for their reception, in the rear of the city, on a ridge of high land, between it and the Bayou St. John, which is probably the ridge anciently separating the waters of the Mississippi from those of Lake Ponchartrain." As the settlers, and later commerce, proceeded up the Mississippi Valley, leprosy seems to have followed, slowly but inexorably; a current map of old and recent leprosy foci shows the affected towns spreading fan-like above New Orleans.

Not all of the present day indigenous leprosy in the Valley can be properly charged to slave traffic; some lepers probably were among the early voyagers. It seems not illogical to include as propagators of the disease, certain French settlers who came from the Province of New Brunswick, Canada, in 1765 and established themselves in Louisiana. Tradition, if not history, traces leprosy in New Brunswick to a French vessel which had been to the Levant trading and which was wrecked at the mouth of the Miramichi river in 1758. It is said that infected clothing was distributed among the fishermen, and that the vessel had Lascars or some Orientals among her crew who were leprosy. Some of the Acadian families were known to have been leprosy as early as 1815. Several Louisiana families, directly descended from the Acadians, continue to be afflicted with leprosy.

Another focus of leprosy was established in the Great Lakes region by immigrants from Norway and Sweden. This focus which, in 1897, numbered 168 cases, has gradually dwindled to an insignificant number.

Thus it was evident more than 50 years ago that some concerted action was necessary if the progress of leprosy in the United States was to be checked, and plans were formulated for having the Federal Government assume control of the situation. Constructive effort, however, did not crystallize until February 3, 1917, when Congress enacted legislation and provided funds for the establishment of a national home for lepers to be under the direction of the U. S. Public Health Service. The entrance of the United States into the World War prevented, for a time, active measures from being taken toward this project, although a committee was appointed to select a site for the proposed leper home. This committee met with great opposition in obtaining a site, because no State cared to cede territory to the Government for use as a leper settlement, and the problem was finally solved by purchasing from the State of Louisiana the estate occupied by the Louisiana Leper Home.

This was developed by the U. S. Public Health Service into the present National Leprosarium at Carville, La., where 306 lepers are now under treatment.

SKULL SHAPE NOT CHANGED BY CHEWING

The old adage has been altered to read, "Tell me *how* you eat and I'll tell you what you are"; but Prof. Earnest A. Hooton of Harvard University has doubts of the validity of this particular article of evolutionary doctrine. In the scientific periodical, *Human Biology*, he discusses this and other skepticisms that have grown up in his mind concerning certain special hypothesis in evolution.

It has for a long time been stoutly maintained by some anthropologists that the peculiar shape of Eskimo skulls was impressed on them by the hard exercise of the jaw muscles of this people, necessitated by their exclusive diet of meat and fish, and to the fact that they prepare leather by chewing animal skins soft. But Prof. Hooton calls attention to the countervailing facts that much of the fish that Eskimos eat has been frozen hard and then thawed again, reducing it to "about

the consistency of ice cream," and that the chewing of hides is exclusively women's work, whereas the peculiar skull shape in Eskimos is most strongly evident on the male side of the igloo.

Among the other beliefs at which Prof. Hooton looks quizzically is the doctrine that Negroes, Malays and other dark peoples have deeply pigmented skins as a result of the constant tanning they get from the tropical sun, while blond peoples have developed in the high northern latitudes where the sun is not so strong. He calls attention to the presence of the pale-skinned "white Indians" of the San Blas tribe in Panama, who have been cropping out in a brown-skinned stock for centuries, in spite of the tropics and in the face of tribal regulations forbidding the marriage of white-skinned Indian men.—*Science Service.*

"SUNSHINE" LAMPS

The tremendous vogue of the use of lamps producing ultra-violet rays has caused considerable consternation among physicians who realize the limitation of these lamps for health and also the fact that there are all sorts of peculiar devices offered to the public, in many instances without any certainty that the device will actually produce good results or that it will provide the ultra-violet that the person wants. In order to bring some control into the field, the Council on Physical Therapy of the American Medical Association has issued a manifesto to manufacturers, defining the limitation of such apparatus and the claims with which it may be sold.

Because of the possible danger of lamps of high intensity, the Council has taken the stand that any "sunshine" lamp sold directly to the public should be so constructed that the radiant energy emitted shall not differ essentially from sunlight. In general, the Council believes that more

conservative claims for the necessity of strong sunlight should be made by the manufacturers of lamps for home use, such statements being restricted to those which can be justified by conclusive scientific evidence. The Council is not convinced that human beings in good health require the great amount of ultra-violet energy which one is led to believe is the case from the advertising and descriptive matter pertaining to some of the so-called "sun-lamps" sold to the public.

A number of the more responsible manufacturers have fully agreed with the opinion of the Council. The emission characteristics of their lamps are in essential agreement with the requirements established by the Council, and in their advertisements they carefully avoid making curative claims. Furthermore, in these advertisements attention is called to the advisability of consulting one's physician before exposing oneself to ultra-violet radiation.

SALICON

Back in the last century it was discovered that when salicylic acid, used in manufacturing industries, was given as an internal medicine it possessed properties that promised startling possibilities for the relief of pain, reduction of fever, and the bringing about of many decided benefits to human beings.

But salicylic acid, itself, could only be given in such very small quantities that effective medication could not be secured.

It was irritating to the stomach. It caused nausea, gastric distress and other digestive disturbances. This situation was not uncommon in the field of medicine, for many of our most efficient remedies have been derived from substances that could not be given in their original forms.

So physicians and chemists began at once to experiment with salicylic acid. They combined it with other compounds. They made numerous derivatives from it. Their purpose, of course, was to keep the good qualities, but at the same time to eliminate its persistent tendency to upset the stomach.

Many preparations that resulted from these experiments were introduced to the medical profession. Each seemed to show some practical improvement over its predecessors, but none seemed capable of being administered in quantities large enough fully to realize upon the possibilities.

Then, in 1900, a German firm of chemists announced a new salicylate—acetylsalicylic acid—known to the public as aspirin. This was a decided improvement over the preceding salicylic combinations and soon grew to be the most popular of them all.

But it has been found that when aspirin is taken into a stomach where more or less free acid is present, decomposition of the aspirin starts promptly. Free salicylic acid is liberated and free acetic acid is formed and these usually cause trouble.

The problem was studied from this angle. The conclusion was reached that if an acid acetylsalicylate was combined with other drugs to meet the digestive conditions as they actually exist, instead of as they theoretically ought to exist, such acid acetylsalicylate should pass through the stomach without irritating it.

As a result of much experimenting, in the early part of 1918 a new preparation, called Salicon, was perfected and showed to physicians. It was used in a small way, gave excellent results, and fulfilled predictions that it would not upset the stomach.

In September of 1918, to help meet the situation created by the inability of thousands to obtain medical treatment because the hospitals were filled to overflowing and there were neither doctors nor nurses sufficient in number adequately to care for the sick, Massachusetts established an open-air camp on Corey Hill which was placed under the direction of Surgeon General Wm. A. Brooks. Almost immediately a large quantity of Salicon was delivered to the camp. Afterwards other camps were established throughout the State and at all of these large camps quantities of this drug were used by the attending doctors in their treatment of those sick therein. It was at these camps that it was first learned that doses could be given in amounts many times greater than aspirin without causing trouble.

AVERTIN

Many distinguished surgeons in Germany, England and in the United States have recently tried out a new anesthetic and found it so remarkably successful, that they believe it will soon take the place of ether in major as well as minor operations. Its chemical name is tribromethyl alcohol and its trade name Avertin. It was developed in the laboratories of the I. G. Farben Industrie, a noted German dyestuff and chemical concern and had been experimented with for about a year by a number of distinguished surgeons, before the results were published and samples sent to England and the United States.

The new anesthetic is administered by rectal injections of small doses of a weak solution and produces deep anesthesia in a shorter time than any other sleep-producing substance known. Even more important is the fact that it produces none of the depressing and detrimental after-effects, caused by the use of ether or by some of the drugs which are injected into the veins or the spine. It has been found, that unconsciousness, lasting three or four hours, can be induced in patients if necessary and that even the largest doses, administered when required, produce no bad effect upon the heart. So great is the confidence of the surgeons who have already experimented with the new anesthetic, that it was decided to use it on King George of England, when he had to undergo an operation a short time ago. There were practically no undesirable after-effects.

So far tribromethyl alcohol has invariably been administered by rectal injection, but it is reported, that an American surgeon, who has tried out the new an-

esthetic in a number of major operations with good success, is now at work to perfect a different method of administering it.

Successful use of this new anesthetic in certain kinds of eye operations is reported by Dr. W. H. Wilmer of the Johns Hopkins Hospital and University in a communication to the American Ophthalmological Society. It was developed in Germany by Dr. Richard Willsträtter of Munich and Dr. Duisberg of Jena.

It has many advantages over ether and is equally safe for certain types of surgery. It is injected instead of being inhaled and is given while the patient is in his bed. He quickly falls into a deep sleep and awakens hours after the operation. The preliminary period of excitement and nervousness is eliminated, as well as a good bit of the post-operative pain and discomfort. Vomiting is infrequent after awakening from avertin anesthesia.

From the surgeon's viewpoint avertin has the added advantage of giving thorough relaxation and there is less bleeding. Pulse and breathing rate are only slightly changed and the blood pressure is lowered a little.

Where general anesthesia is required, avertin is a safe and valuable addition to the list of drugs used in ophthalmic surgery. It was also pointed out that avertin cannot be used safely where the patients are aged or very weak or when certain diseases are present.

The preparation and administration of the drug require the attention of a member of the hospital staff, either doctor or competent anesthetist, who must give most of his time to this duty.

ADMINISTRATION OF PUBLIC DOMAIN

Is the Boulder Dam wrangle to be repeated? The same endless disputes between states will result if the Public Lands, comprising territory in eleven states and spread over the watersheds that feed the Mississippi, Missouri, Rio Grande, Colorado, Columbia, and other great rivers, are turned over to them, says Dr. George Stewart, nationally known agronomist, in *American Forests and Forest Life*.

The Commission on Conservation and Administration of the Public Domain appointed by President Hoover is investigating the feasibility of turning over the surface rights of the public domain lands to the states.

That such a plan does not represent mature thought and certainly not a definite, clear-cut move towards conservation, Dr. Stewart contends. He maintains that the evidence is favorable to federal rather than to state control.

"The tangle of water rights and of power privileges, on the Colorado River has thrust into our faces the danger of conflicting state, municipal, and private interests. A whole series of such far-reaching results are bound to arise around the problems of grazing, of timber control, of soil erosion, and of monopoly privileges on the Public Domain."

The territory in question comprises more than 190,000,000 acres, over half of which lies in the eight Rocky Mountain states. In the three Pacific Coast states there are some 34,000,000 acres, the remaining 1,000,000 acres are in states east of the Rocky Mountains.

Conservation of timber, watershed, and grazing resources can best and most economically be handled under a federal system. In fact, Dr. Stewart questions whether the states are financially able to undertake the control of the Public Domain, and whether it would be a kindness to return the lands to them.

His argument for federal control of this vast acreage is based on ten reasons which he outlines as follows:

1. A federal agency can manage these lands under one head. Under state control there would be eleven or more separate heads, many of which would be competitive.

2. There could be a unit correlation between the summer ranges on the National Forests and the winter and spring ranges on the Public Domain. Winter ranges in the Utah-Nevada desert receive sheep from the summer ranges in Colorado, Arizona, Nevada, and in some cases as far as Oregon.

3. Under state control there would have to be pacts for interstate grazing control. Who is there that has studied the progress of the Colorado Compact who would like to repeat the experience every time an interstate problem arose?

4. Only the proper federal agency can successfully prevent grazing in one State which will cause destructive silting of reservoirs in another state.

5. The federal government has a staff of men accumulated and trained during the last twenty-five years who would have to be imitated eleven times. All large business enterprises are consolidating in order to provide managerial ability of a high order.

6. Federal employees are under Civil Service. Petty politics would be avoided.

7. Under state control the Public Domain would be so disposed of and so dissipated that the people would lose the benefits.

8. Money spent by federal government on roads and reclamation would undoubtedly be discontinued.

9. Research information can be better and more economically provided under federal control.

10. The costs to states of handling grazing lands would be considerably higher than to the Federal government—probably twice as high.

INDIANS IN NEW YORK STATE

Secretary of the Interior Wilbur has submitted to Honorable Lynn J. Frazier, Chairman of the Senate Committee on Indian Affairs, a letter in connection with a hearing before a subcommittee of the Committee on Indian Affairs of the United States Senate, when it was moved that "the Indian Bureau and the Department of the Interior be invited and requested to make a special study of the New York Indian situation and advise the Congress of their legal rights together with such suggestions for legislation as the Department of the Interior will suggest and recommend."

The situation with respect to the Indians in the State of New York is somewhat peculiar and is entirely different from that of most of the other Indian problems with which this Department must deal, particularly those west of the Mississippi River. This is due in large measure to the fact that New York was one of thirteen original colonies and the legal title to none of the lands in that State is in the United States, other than such as may have been acquired by purchase, or by condemnation for public purposes, as Federal buildings, military posts, etc. Again, shortly after the Revolutionary War, particularly prior to the adoption of our Federal Constitution and ever since that date, under the doctrine of "States rights" so strongly prevalent in those days, the State of New York has dealt directly with these Indian tribes claiming lands within her borders. In some instances such transactions were had with the sanction of the Federal Government and in others without such sanction other than such as might be implied. That is, as to those transactions between the Indians and the State not expressly sanctioned, no protest or opposition thereto has ever been raised, at least in so far as the legislative and executive branches of the Federal Government are concerned.

The State of New York has always assumed the burden of establishing and maintaining schools for the education of the Indian youth within her borders; has constructed improved highways through the reservations there and to some extent at least has enforced sanitation, health and other public measures of this kind

among these people; all without expense to the Federal Government. In short, the State has heretofore exercised the usual prerogatives of sovereignty and jurisdiction over these Indians, while the Federal Government to a large extent has not. This may be due in some measure to the fact that the Congress has never expressly directed this or any other department of the Federal Government to assume active control and supervision over the New York Indians such as is found in the Act of July 27, 1868 (15 Stat. L., 228), with respect to the Cherokee Indians of North Carolina. Having no such legislation at hand and having no appropriations expressly made available for the purpose of carrying on any extensive activities with respect to the Indians in New York, this Department has not felt empowered to assume active control of the situation there, such as is now exercised over most of the other Indians of the United States. This should not be understood to mean that we now recommend or advocate legislation by Congress looking to an enlarged jurisdiction in this Department over the Indians of New York, but rather is here pointed out solely for the purpose of disclosing the basic reason why the activities of the Federal Government and of this Department with respect to these Indians in the State of New York have been largely passive rather than active.

At sundry times in the past the situation with respect to the Indians in New York has been presented to Congress, either responsive to legislation directing an investigation and report, or else in connection with bills then pending looking to an allotment in severalty of the lands in the reservations in that State. In this connection see the Act of August 15, 1894 (28 Stat. L., 301), and Senate Document No. 53, 53d Congress, 3d Session; also House Bill No. 7262, 58th Congress, 2d Session, known as the Vreeland Bill, and House Bill No. 18735, 63d Congress, known as the Clancy Bill; the two bills last mentioned being both designed to provide for an allotment of the lands belonging to these Indians. House Document No. 1590, 63d Congress, 3d Session, containing the report of this Department on the bill last

mentioned, presents an exhaustive resume of the situation with respect to the Indians in New York, including an historical outline of the origin and *locus* of the title to the lands within each of the several Indian reservations in that State. No substantial change has occurred in the situation with respect to any of these reservations since the submission of that report in 1914, and in order to avoid unnecessary repetition of the facts disclosed by that report, it is suggested that your committee consider the report here made largely as supplemental to the one presented in 1914.

Congress undoubtedly has ample power and jurisdiction over the Indians in New York to enact such legislation as may be deemed necessary in connection with their affairs. Whether that should be by way of increasing Federal activities in their behalf or by strengthening the authority and prerogatives of the State in the matter should be seriously considered. In view of the fact that the State has heretofore always assumed the right to exercise sovereignty and jurisdiction over these people, it is recommended that the activities of the State in this respect be in no manner curtailed.

Rather if any legislation by Congress along such lines is now to be had, that it be with a view of removing any doubts that may have heretofore existed with respect to the authority and jurisdiction of the State in the premises. Legislation by Congress expressly subjecting the Indians in New York to the laws of that State, without impairing any of their property or rights under existing treaties with the United States, would remove from the field of controversy the frequently mooted question of jurisdiction, State or Federal, over these Indians, and would undoubtedly prove helpful, particularly in such matters as the enforcement of marriage and divorce laws of the State, and crimes and misdemeanors committed by the Indians within the existing reservations there. Such legislation, while helpful, would af-

ford only a partial solution of the problem, as it would still leave the property rights of those Indians under existing treaties with the United States to be dealt with. In this connection it may be pointed out that by the treaty of November 11, 1794 (7 Stat. L., 44), with the Six Nations of New York, these Indians were practically guaranteed peaceful possession of their soil until they chose to sell the same "to the people of the United States, who have the right to purchase" (Article 2). Just what is intended by the expression "people of the United States" is not entirely clear; that is, assuming these Indians to be ready to part with their title whether the same is to be sold only to the United States Government or may be sold to the State, or even to non-alien third parties, including individual citizens of the United States, artificial entities organized pursuant to State laws as a corporation or even to unincorporated joint stock companies or associations. In this latter connection, attention is invited to pages 15 to 19 inclusive of House Document No. 1590, 63d Congress, 3d Session, with respect to the claims of the Ogden Land Company, successor in interest to the Holland Land Company, in and to the lands embraced in the Allegany, Cattaraugus, and a part of the Tuscarora Reservations in New York.

Frankly, the situation with respect to these Indians is so complex that before offering any definite recommendations as to the form of legislation best calculated to afford an effective solution of the entire problem, and in view of the jurisdiction heretofore exercised by the State of New York over the Indians within her borders, it is suggested that your committee consider the advisability of inviting representatives of the State to present their views with respect to the matter.

We will be glad, of course, to cooperate at all times with any representatives of the State and other parties interested in working out an effective solution of the problem, legislative and otherwise.

DECLARATION OF INDEPENDENCE

Unanimously adopted, July 4, 1776; signed by 54 delegates, Aug. 2, 1776; by Thos. McKean, Del., in Oct., and by Matthew Thornton, N. Hamp., in Nov. of that year.

When in the Course of human events it becomes necessary for one people to dissolve the political bands which have connected them with another, and to assume among the powers of the earth, the separate and equal station to which the Laws of Nature and of Nature's God entitle them, a decent respect to the opinions of mankind requires that they should declare the causes which impel them to the separation.

We hold these truths to be self-evident, that all men are created equal, that they are endowed by their Creator with certain unalienable Rights, that among these are Life, Liberty and the pursuit of Happiness. That to secure these rights, Governments are instituted among Men, deriving their just powers from the consent of the governed, That whenever any Form of Government becomes destructive of these ends, it is the Right of the People to alter or to abolish it, and to institute new Government, laying its foundation on such principles and organizing its powers in such form, as to them shall seem most likely to effect their Safety and Happiness. Prudence, indeed, will dictate that Governments long established should not be changed for light and transient causes; and accordingly all experience hath shewn, that mankind are more disposed to suffer, while evils are sufferable, than to right themselves by abolishing the forms to which they are accustomed. But when a long train of abuses and usurpations, pursuing invariably the same object evinces a design to reduce them under absolute Despotism, it is their right, it is their duty, to throw off such Government, and to provide new Guards for their future security. Such has been the patient sufferance of these Colonies; and such is now the necessity which constrains them to alter their former Systems of Government. The history of the present King of Great Britain is a history of repeated injuries and usurpations, all having in direct object the establishment of an absolute Tyranny over these States. To prove this, let Facts be submitted to a candid world.

He has refused his Assent to Laws, the most wholesome and necessary for the public good.

He has forbidden his Governors to pass Laws of immediate and pressing importance, unless suspended in their operation till his Assent should be obtained, and when so suspended, he has utterly neglected to attend to them.

He has refused to pass other Laws for the accommodation of large districts of people, unless those people would relinquish the right of Representation in the Legislature, a right inestimable to them and formidable to tyrants only.

He has called together legislative bodies at places unusual, uncomfortable, and distant from the depository of their public Records, for the sole purpose of fatiguing them into compliance with his measures.

He has dissolved Representative Houses repeatedly, for opposing with manly firmness his invasions on the rights of the people.

He has refused for a long time, after such dissolutions, to cause others to be elected; whereby the Legislative powers, incapable of Annihilation, have returned to the People at large for their exercise; the State remaining in the meantime exposed to all the dangers of invasion from without, and convulsions within.

He has endeavoured to prevent the population of these States; for that purpose obstructing the Laws for Naturalization of Foreigners; refusing to pass others to encourage their migrations hither, and raising the conditions of new Appropriations of Lands.

He has obstructed the Administration of Justice, by refusing his Assent to Laws for establishing Judiciary powers.

He has made Judges dependent on his Will alone, for the tenure of their offices, and the amount and payment of their salaries.

He has erected a multitude of New Offices, and sent hither swarms of Officers to harass our people, and eat out their substance.

He has kept among us, in times of peace,

Standing Armies, without the Consent of our legislatures.

He has affected to render the Military independent of and superior to the Civil power.

He has combined with others to subject us to a jurisdiction foreign to our constitution and unacknowledged by our laws;

us in many cases of the benefits of Trial by Jury: For transporting us beyond Seas to be tried for pretended offences: For abolishing the free System of English Laws in a neighbouring Province, establishing therein an Arbitrary government, and enlarging its Boundaries so as to render it at once an example and fit instru-

(Compiled by Simon Newton, Detroit)

Name	Delegate From	Occupation	Birthplace	Date of Birth	Date of Death
Adams, John	Mass.	Lawyer	Braintree (now Quincy), Mass.	Oct. 30, 1735	July 4, 1826
Adams, Samuel	Mass.	Merchant	Boston, Mass.	Sept. 27, 1722	Oct. 2, 1803
Bartlett, Josiah	N. H.	Physician	Amesbury, Mass.	Nov. 21, 1729	May 19, 1795
Braxton, Carter	Va.	Planter	Newington, Va.	Sept. 10, 1736	Oct. 10, 1797
Carroll, Charles	Md.	Lawyer	Annapolis, Md.	Sept. 20, 1737	Nov. 14, 1832
Chase, Samuel	Md.	Lawyer	Somerset County, Md.	April 17, 1741	June 19, 1811
Clark, Abraham	N. J.	Lawyer	Elizabethtown, N. J.	Feb. 15, 1726	Sept. 15, 1794
Clymer, George	Pa.	Merchant	Philadelphia, Pa.	Jan. 24, 1739	Jan. 23, 1813
Ellery, William	R. I.	Lawyer	Newport, R. I.	Dec. 22, 1737	Feb. 15, 1820
Floyd, William	N. Y.	Farmer	Brookhaven, N. Y.	Dec. 17, 1734	Aug. 4, 1821
Franklin, Benjamin	Pa.	Printer	Boston, Mass.	Jan. 17, 1706	April 17, 1790
Gerry, Elbridge	Mass.	Merchant	Marblehead, Mass.	July 17, 1744	Nov. 23, 1814
Gwynnett, Button	Ga.	Merchant	Down Hatherly, Glo'shire, Eng.	April 10, 1735	May 27, 1777
Hall, Lyman	Ga.	Physician	Wallingford, Conn.	April 12, 1724	Oct. 19, 1790
Hancock, John	Mass.	Merchant	Quincy, Mass.	Jan. 12, 1737	Oct. 8, 1793
Harrison, Benjamin	Va.	Farmer	Berkeley, Va.	(About) 1740	April, 1791
Hart, John	N. J.	Farmer	Hopewell, N. J.	1768	1780
Hewes, Joseph	N. C.	Lawyer	Kingston, N. J.	1730	Nov. 10, 1779
Heyward, Thomas, jr.	S. C.	Lawyer	St. Luke's Parish, S. C.	1746	Mar. 6, 1809
Hooper, William	N. C.	Lawyer	Boston, Mass.	June 17, 1742	Oct. 1, 1790
Hopkins, Stephen	R. I.	Farmer	Selkuate, R. I.	Mar. 7, 1707	July 13, 1785
Hopkinson, Francis	N. J.	Lawyer	Philadelphia, Pa.	Sept. 21, 1737	May 9, 1791
Huntington, Samuel	Conn.	Lawyer	Windham, Conn.	July 3, 1731	Jan. 5, 1796
Jefferson, Thomas	Va.	Lawyer	Shadwell, Va.	April 2, 1743	July 4, 1826
Lee, Richard Henry	Va.	Soldier	Stratford, Va.	Jan. 20, 1732	June 19, 1794
Lee, Francis Lightfoot	Va.	Farmer	Stratford, Va.	Oct. 14, 1734	April 3, 1797
Lewis, Francis	N. Y.	Merchant	Llandaff, Wales	Mar. 1713	Dec. 19, 1803
Livingston, Philip	N. Y.	Merchant	Albany, N. Y.	Jan. 15, 1716	June 12, 1778
Lynch, Thomas, jr.	S. C.	Lawyer	Prince George Parish, S. C.	Aug. 5, 1749	(At Sea) 1779
McKean, Thomas	Del.	Lawyer	New London, Pa.	Mar. 19, 1734	June 24, 1817
Middleton, Arthur	S. C.	Lawyer	Middleton Place, S. C.	June 26, 1742	Jan. 1, 1787
Morris, Lewis	N. Y.	Farmer	Morrisania, N. Y.	1726	Jan. 22, 1798
Morris, Robert	Pa.	Merchant	Liverpool, England	Jan. 20, 1734	May 8, 1806
Morton, John	Pa.	Surveyor	Ridley, Pa.	1724	April, 1777
Nelson, Thomas, jr.	Va.	Statesman	Yorktown, Va.	Dec. 26, 1738	Jan. 4, 1789
Paea, William	Md.	Lawyer	Wyehall, Md.	Oct. 31, 1740	1799
Paine, Robert Treat	Mass.	Lawyer	Boston, Mass.	Mar. 11, 1731	May 11, 1814
Penn, John	N. C.	Lawyer	Caroline County, Va.	May 17, 1741	Sept. 1, 1788
Read, George	Del.	Lawyer	Cecil County, Md.	Sept. 17, 1733	Sept. 21, 1798
Rodney, Caesar	Del.	General	Dover, Del.	Oct. 7, 1728	June 29, 1784
Ross, George	Pa.	Lawyer	Newcastle, Del.	1730	July, 1779
Rush, Benjamin	Pa.	Physician	Rybery Township, Pa.	Dec. 24, 1745	April 19, 1813
Rutledge, Edward	S. C.	Lawyer	Charleston, S. C.	Nov. 23, 1749	Jan. 23, 1800
Sherman, Roger	Conn.	Shoemaker	Newton, Mass.	April 19, 1721	July 23, 1793
Smith, James	Pa.	Lawyer	Ireland	(About) 1720	July 11, 1806
Stockton, Richard	N. J.	Lawyer	Near Princeton, N. J.	Oct. 1, 1730	Feb. 28, 1781
Stone, Thomas	Md.	Lawyer	Charles County, Md.	1743	Oct. 5, 1787
Taylor, George	Pa.	Physician	Ireland	1716	Oct. 23, 1781
Thornton, Matthew	N. H.	Physician	Ireland	(About) 1714	June 24, 1803
Walton, George	Ga.	Lawyer	Frederick County, Va.	1740	Feb. 2, 1804
Whipple, William	N. H.	Sailor	Kittery, Me.	Jan. 14, 1730	Nov. 28, 1785
Williams, William	Conn.	Statesman	Lebanon, Conn.	April 18, 1731	Aug. 2, 1811
Wilson, James	Pa.	Lawyer	Near St. Andrews, Scotland	Sept. 14, 1742	Aug. 28, 1798
Witherspoon, John	N. J.	Minister	Gifford, Scotland	Feb. 5, 1722	Sept. 15, 1794
Wolcott, Oliver	Conn.	Physician	Windsor, Conn.	Nov. 26, 1726	Dec. 1, 1797
Wythe, George	Va.	Lawyer	Elizabeth City, Va.	1726	June 8, 1806

giving his Assent to their Acts of pretended Legislation: For quartering large bodies of armed troops among us: For protecting them by a mock Trial from punishment for any Murders which they should commit on the Inhabitants of these States: For cutting off our Trade with all parts of the world: For imposing Taxes on us without our Consent: For depriving

us in many cases of the benefits of Trial by Jury: For transporting us beyond Seas to be tried for pretended offences: For abolishing the free System of English Laws in a neighbouring Province, establishing therein an Arbitrary government, and enlarging its Boundaries so as to render it at once an example and fit instru-

He has abdicated Government here by

declaring us out of his Protection and waging War against us.

He has plundered our seas, ravaged our Coasts, burnt our towns, and destroyed the lives of our people.

He is at this time transporting large Armies of foreign Mercenaries to complete the works of death, desolation and tyranny, already begun with circumstances of cruelty and perfidy scarcely paralleled in the most barbarous ages, and totally unworthy the Head of a civilized nation.

He has constrained our fellow Citizens taken Captive on the high Seas to bear Arms against their Country, to become the executioners of their friends and Brethren, or to fall themselves by their Hands.

He has excited domestic insurrections amongst us, and has endeavoured to bring on the inhabitants of our frontiers, the merciless Indian Savages, whose known rule of warfare is an undistinguished destruction of all ages, sexes and conditions. In every stage of these Oppressions We have Petitioned for Redress in the most humble terms. Our repeated Petitions have been answered only by repeated injury. A Prince, whose character is thus marked by every act which may define a Tyrant, is unfit to be the ruler of a free people. Nor have We been wanting in attentions to our British brethren. We have warned them from time to time of attempts by their legislature to extend an unwarrantable jurisdiction over us. We have reminded them of the circumstances of our emigration and settlement here. We have appealed to their native justice and magnanimity, and we have conjured them by the ties of our common kindred to disavow these usurpations, which would inevitably interrupt our connections and correspondence. They too have been deaf to the voice of justice and of consanguinity. We must, therefore, acquiesce in the necessity, which denounces our Separation, and hold them, as we hold the rest of mankind, Enemies in War, in Peace Friends.

WE, THEREFORE, the Representatives of the United States of America, in General Congress, Assembled, appealing to the Supreme Judge of the world for the rectitude of our intentions, do, in the Name, and by authority of the good People of these Colonies, solemnly publish and declare, That these United Colonies are, and of Right ought to be Free and

Independent States; that they are Absolved from all Allegiance to the British Crown, and that all political connection between them and the State of Great Britain is and ought to be totally dissolved; and that as Free and Independent States, they have full Power to levy War, conclude Peace, contract Alliances, establish Commerce, and to do all other Acts and Things which Independent States may of right do. And for the support of this Declaration, with a firm reliance on the protection of Divine Providence, we mutually pledge to each other our Lives, our Fortunes, and our sacred Honor.

The oldest signer when the signatures were affixed was Benjamin Franklin, the next oldest was Stephen Hopkins.

The first of the signers to die was John Morton; the second was Button Gwinnett.

The earliest known attempt in the American colonies of a declaration of independence was at a town meeting at Mendon, Mass., in 1773.

There was also the Mecklenburg, N. C., declaration for independence, May 31, 1775.

The date in the above table given as that of the birth of Button Gwinnett is the date of his baptism, as recorded in the parish register at Down Hatherly, Gloucestershire, England, where the Georgia signer was born. It was customary in those days to baptize within ten days of birth.

A signature of Button Gwinnett, attached to a will as a witness, the document having been filed in Georgia, was sold at auction at New York City in April, 1926, for \$22,500. The state of Georgia sued, in 1927, for possession of the will, with the signatures, but the supreme court of Albany, N. Y., ruled that the document was private property. Gwinnett was killed in a duel.

A letter of the Marine Committee, at Philadelphia, July 12, 1776, containing the signatures of Robert Morris, Button Gwinnett, Francis Lewis, George Read, and Arthur Middleton, was sold for \$51,000 on March 15, 1927. Another Gwinnett signature sold for \$28,500, in Nov., 1926, and still another for \$18,600 on Nov. 4, 1927, at N. Y. City.

In May another of his signatures was discovered in Georgia by Miss Ruth Blair, State Historian. It was appended to a con-

firmation of a land grant. Evidently the actual grantee was unable to write, for the signature reads "Button Gwinnett for John Barber." The item is dated June 30, 1767. An autograph of Thomas Lynch, Jr., a signer, was sold at N. Y. City in 1929 for \$9,500. It was signed on Aug. 22, 1775, and was on a receipt for £50 in payment by South Carolina for one of Lynch's father's slaves who had been executed.

The signers and their families were proscribed as traitors by the British Government and rewards of £500 were offered for their apprehension.

CONSTITUTION OF THE UNITED STATES

The Constitution originally consisted of a Preamble and seven Articles, and in that form was ratified by a convention of the States, Sept. 17, 1787. The Government under the Constitution was declared in effect on the first Wednesday in March, 1789. The signers of the original Constitution, by virtue of their membership in Congress, were:

GEO. WASHINGTON, *President and deputy from Virginia*. NEW HAMPSHIRE—John Langdon, Nicholas Gilman. MASSACHUSETTS—Nathaniel Gorham, Rufus King. CONNECTICUT—Wm. Saml. Johnson, Roger Sherman. NEW YORK—Alexander Hamilton. NEW JERSEY—Wil. Livingston, David Brearley, Wm. Patterson, Jona. Dayton. PENNSYLVANIA—B. Franklin, Robt. Morris, Thos. Fitzsimons, James Wilson, Thomas Mifflin, Geo. Clymer, Jared Ingersoll, Gouv. Morris. DELAWARE—Geo. Read, John Dickinson, Jaco. Broom, Gunning Bedford jun., Richard Basset. MARYLAND—James McHenry, Danl. Carroll, Dan. of St. Thos. Jenifer. VIRGINIA—John Blair, James Madison, Jr. NORTH CAROLINA—Wm. Blount, Hu. Williamson, Richd. Dobbs Spaight. SOUTH CAROLINA—J. Rutledge, Charles Pinckney, Charles Cotesworth Pinckney, Pierce Butler. GEORGIA—William Few, Abr. Baldwin. Attest: WILLIAM JACKSON, *Secretary*.

The Constitution was ratified by the thirteen original States in the following order:

Delaware, December 7, 1787 (yeas, 30), unanimous.

Pennsylvania, December 12, 1787, vote 43 to 23.

New Jersey, December 18, 1787 (yeas, 38), unanimous.

Georgia, January 2, 1788 (yeas, 26), unanimous.

Connecticut, January 9, 1788, vote 128 to 40.

Massachusetts, February 6, 1788, vote 187 to 168.

Maryland, April 28, 1788, vote 63 to 11.

South Carolina, May 23, 1788, vote 149 to 73.

New Hampshire, June 21, 1788, vote 57 to 46.

Virginia, June 26, 1788, vote 89 to 79.

New York, July 26, 1788, vote 30 to 27.

North Carolina, November 21, 1789, vote 194 to 77.

Rhode Island, May 29, 1790, vote 34 to 32.

(Vermont, by convention, ratified Jan. 10, 1791; and Congress, Feb. 18, 1791, admitted that State into the Union.)

PREAMBLE.

We, the people of the United States, in order to form a more perfect Union, establish justice, insure domestic tranquillity, provide for the common defence, promote the general welfare, and secure the blessings of liberty to ourselves and our posterity, do ordain and establish this CONSTITUTION for the United States of America.

ARTICLE I.

Section 1—(Legislative powers; in whom vested:)

All legislative powers herein granted shall be vested in a Congress of the United States, which shall consist of a Senate and House of Representatives.

Section 2—(House of Representatives, how and by whom chosen. Qualifications of a Representative. Representatives and direct taxes, how apportioned. Enumeration. Vacancies to be filled. Power of choosing officers, and of impeachment.)

1. The House of Representatives shall be composed of members chosen every second year by the people of the several States, and the electors in each State shall have the qualifications requisite for electors of the most numerous branch of the State Legislature.

2. No person shall be a Representative who shall not have attained to the age of twenty-five years and been seven years a citizen of the United States, and who shall not, when elected, be an inhabitant of that State in which he shall be chosen.

3. Representatives and direct taxes shall be apportioned among the several States which may be included within this Union according to their respective numbers, which shall be determined by adding to the whole number of free persons, including those bound to service for a term of years, and excluding Indians not taxed, three-fifths of all other persons. The actual enumeration shall be made within three years after the first meeting of the Congress of the United States, and within every subsequent term of ten years, in such manner as they shall by law direct. The number of Representatives shall not exceed one for every thirty thousand, but each State shall have at least one Representative; and until such enumeration shall be made, the State of New Hampshire shall be entitled to choose 3; Massachusetts, 8; Rhode Island and Providence Plantations, 1; Connecticut, 5; New York, 6; New Jersey, 4; Pennsylvania, 8; Delaware, 1; Maryland, 6; Virginia, 10; North Carolina, 5; South Carolina, 5, and Georgia, 3.*

4. When vacancies happen in the representation from any State, the Executive Authority thereof shall issue writs of election to fill such vacancies.

5. The House of Representatives shall choose their Speaker and other officers, and shall have the sole power of impeachment.

Section 3—(Senators, how and by whom chosen. How classified. State Executive, when to make temporary appointments, in case, etc. Qualifications of a Senator. President of the Senate, his right to vote. President pro tem., and other officers of the Senate, how chosen. Power to try impeachments. When President is tried, Chief Justice to preside. Sentence.)

1. The Senate of the United States shall be composed of two Senators from each State, chosen by the Legislature thereof,

*See Article XIV., Amendments.

for six years; and each Senator shall have one vote.

2. Immediately after they shall be assembled in consequence of the first election, they shall be divided as equally as may be into three classes. The seats of the Senators of the first class shall be vacated at the expiration of the second year, of the second class at the expiration of the fourth year, and of the third class at the expiration of the sixth year, so that one-third may be chosen every second year; and if vacancies happen by resignation, or otherwise, during the recess of the Legislature of any State, the Executive thereof may make temporary appointment until the next meeting of the Legislature, which shall then fill such vacancies.

3. No person shall be a Senator who shall not have attained to the age of thirty years, and been nine years a citizen of the United States, and who shall not, when elected, be an inhabitant of that State for which he shall be chosen.

4. The Vice President of the United States shall be President of the Senate, but shall have no vote unless they be equally divided.

5. The Senate shall choose their other officers, and also a President pro tempore, in the absence of the Vice President, or when he shall exercise the office of President of the United States.

6. The Senate shall have the sole power to try all impeachments. When sitting for that purpose, they shall be on oath or affirmation. When the President of the United States is tried, the Chief Justice shall preside; and no person shall be convicted without the concurrence of two-thirds of the members present.

7. Judgment of cases of impeachment shall not extend further than to removal from office, and disqualification to hold and enjoy any office of honor, trust, or profit under the United States; but the party convicted shall nevertheless be liable and subject to indictment, trial, judgment, and punishment, according to law.

Section 4—(Times, etc., of holding elections, how prescribed. One session in each year.)

1. The times, places, and manner of holding elections for Senators and Representatives shall be prescribed in each State

by the Legislature thereof; but the Congress may at any time by law make or alter such regulations, except as to places of choosing Senators.

2. The Congress shall assemble at least once in every year, and such meeting shall be on the first Monday in December, unless they shall by law appoint a different day.

Section 5—(Membership, Quorum, Adjournments. Rules. Power to punish or expel. Journal. Time of adjournments, how limited, etc.)

1. Each House shall be the judge of the elections, returns, and qualifications of its own members, and a majority of each shall constitute a quorum to do business; but a smaller number may adjourn from day to day, and may be authorized to compel the attendance of absent members in such manner and under such penalties as each House may provide.

2. Each House may determine the rules of its proceedings, punish its members for disorderly behavior, and with the concurrence of two-thirds expel a member.

3. Each House shall keep a journal of its proceedings, and from time to time publish the same, excepting such parts as may in their judgment require secrecy; and the yeas and nays of the members of either House on any question shall, at the desire of one-fifth of those present, be entered on the journal.

4. Neither House, during the session of Congress shall, without the consent of the other, adjourn for more than three days, nor to any other place than that in which the two Houses shall be sitting.

Section 6—(Compensation. Privileges. Disqualification in certain cases.)

1. The Senators and Representatives shall receive a compensation for their services to be ascertained by law, and paid out of the Treasury of the United States. They shall in all cases, except treason, felony, and breach of the peace, be privileged from arrest during their attendance at the session of their respective Houses, and in going to and returning from the same; and for any speech or debate in either House they shall not be questioned in any other place.

2. No Senator or Representative shall, during the time for which he was elected, be appointed to any civil office under the authority of the United States which shall have been created, or the emoluments whereof shall have been increased during such time; and no person holding any office under the United States shall be a member of either House during his continuance in office.

Section 7—(House to originate all revenue bills. Veto. Bill may be passed by two-thirds of each House, notwithstanding, etc. Bill, not returned in ten days, to become a law. Provisions as to orders, concurrent resolutions, etc.)

1. All bills for raising revenue shall originate in the House of Representatives, but the Senate may propose or concur with amendments, as on other bills.

2. Every bill which shall have passed the House of Representatives and the Senate shall, before it becomes a law, be presented to the President of the United States; if he approve, he shall sign it, but if not, he shall return it, with his objections, to that House in which it shall have originated, who shall enter the objections at large on their journal, and proceed to reconsider it. If after such reconsideration two-thirds of that House shall agree to pass the bill, it shall be sent, together with the objections, to the other House, by which it shall likewise be reconsidered; and if approved by two-thirds of that House it shall become a law. But in all such cases the votes of both Houses shall be determined by yeas and nays, and the names of the persons voting for and against the bill shall be entered on the journal of each House respectively. If any bill shall not be returned by the President within ten days (Sundays excepted) after it shall have been presented to him, the same shall be a law in like manner as if he had signed it, unless the Congress by their adjournment prevent its return; in which case it shall not be a law.

3. Every order, resolution, or vote to which the concurrence of the Senate and House of Representatives may be necessary (except on a question of adjournment) shall be presented to the President of the United States; and before the same

shall take effect shall be approved by him, or being disapproved by him, shall be re-passed by two-thirds of the Senate and the House of Representatives, according to the rules and limitations prescribed in the case of a bill.

Section 8—(Powers of Congress.)

1. The Congress shall have power:

To lay and collect taxes, duties, imposts, and excises, to pay the debts and provide for the common defence and general welfare of the United States; but all duties, imposts, and excises shall be uniform throughout the United States.

2. To borrow money on the credit of the United States.

3. To regulate commerce with foreign nations, and among the several States, and with the Indian tribes.

4. To establish an uniform rule of naturalization and uniform laws on the subject of bankruptcies throughout the United States.

5. To coin money, regulate the value thereof, and of foreign coin, and fix the standard of weights and measures.

6. To provide for the punishment of counterfeiting the securities and current coin of the United States.

7. To establish post-offices and post-roads.

8. To promote the progress of science and useful arts by securing for limited times to authors and inventors the exclusive rights to their respective writings and discoveries.

9. To constitute tribunals inferior to the Supreme Court.

10. To define and punish piracies and felonies committed on the high seas, and offences against the law of nations.

11. To declare war, grant letters of marque and reprisal, and make rules concerning captures on land and water.

12. To raise and support armies, but no appropriation of money to that use shall be for a longer term than two years.

13. To provide and maintain a navy.

14. To make rules for the government and regulation of the land and naval forces.

15. To provide for calling forth the

militia to execute the laws of the Union, suppress insurrections, and repel invasions.

16. To provide for organizing, arming, and disciplining the militia, and for governing such part of them as may be employed in the service of the United States, reserving to the States respectively the appointment of the officers, and the authority of training the militia according to the discipline prescribed by Congress.

17. To exercise exclusive legislation in all cases whatsoever over such district (not exceeding ten miles square) as may, by cession of particular States and the acceptance of Congress, become the seat of Government of the United States, and to exercise like authority over all places purchased by the consent of the Legislature of the State in which the same shall be, for the erection of forts, magazines, arsenals, drydocks, and other needful buildings.

18. To make all laws which shall be necessary and proper for carrying into execution the foregoing powers and all other powers vested by this Constitution in the Government of the United States, or in any department or officer thereof.

Section 9—(Provision as to migration or importation of certain persons. Habeas Corpus. Bills of attainder, etc. Taxes, how apportioned. No export duty. No commercial preference. Money, how drawn from Treasury, etc. No titular nobility. Officers not to receive presents, etc.)

1. The migration or importation of such persons as any of the States now existing shall think proper to admit shall not be prohibited by the Congress prior to the year one thousand eight hundred and eight, but a tax or duty may be imposed on such importation, not exceeding ten dollars for each person.

2. The privilege of the writ of habeas corpus shall not be suspended, unless when in cases of rebellion or invasion the public safety may require it.

3. No bill of attainder or ex post facto law shall be passed.

4. No capitation or other direct tax shall be laid, unless in proportion to the census or enumeration hereinbefore directed to be taken.

5. No tax or duty shall be laid on articles exported from any State.

6. No preference shall be given by any regulation of commerce or revenue to the ports of one State over those of another, nor shall vessels bound to or from one State be obliged to enter, clear, or pay duties in another.

7. No money shall be drawn from the Treasury but in consequence of appropriations made by law; and a regular statement and account of the receipts and expenditures of all public money shall be published from time to time.

8. No title of nobility shall be granted by the United States. And no person holding any office of profit or trust under them shall, without the consent of the Congress, accept of any present, emolument, office, or title of any kind whatever from any king, prince, or foreign state.

Section 10—(States prohibited from the exercise of certain powers.)

1. No State shall enter into any treaty, alliance, or confederation, grant letters of marque and reprisal, coin money, emit bills of credit, make anything but gold and silver coin a tender in payment of debts, pass any bill of attainder, ex post facto law, or law impairing the obligation of contracts, or grant any title of nobility.

2. No State shall, without the consent of the Congress, lay any impost or duties on imports or exports, except what may be absolutely necessary for executing its inspection laws, and the net produce of all duties and imposts, laid by any State on imports or exports, shall be for the use of the Treasury of the United States; and all such laws shall be subject to the revision and control of the Congress.

3. No State shall, without the consent of Congress, lay any duty of tonnage, keep troops or ships of war in time of peace, enter into agreement or compact with another State, or with a foreign power, or engage in war, unless actually invaded, or in such imminent danger as will not admit of delay.

ARTICLE II.

Section 1—(President; his term of office. Electors of President; number and how appointed. Electors to vote on same day. Qualification of Presi-

dent. On whom his duties devolve in case of his removal, death, etc. President's compensation. His oath of office.)

1. The Executive power shall be vested in a President of the United States of America. He shall hold his office during the term of four years, and, together with the Vice-President, chosen for the same term, be elected as follows:

2. Each State shall appoint, in such manner as the Legislature thereof may direct, a number of electors equal to the whole number of Senators and Representatives to which the State may be entitled in the Congress; but no Senator or Representative or person holding an office of trust or profit under the United States shall be appointed an elector.

3. The electors shall meet in their respective States and vote by ballot for two persons, of whom one at least shall not be an inhabitant of the same State with themselves. And they shall make a list of all the persons voted for, and of the number of votes for each, which list they shall sign and certify and transmit, sealed, to the seat of the Government of the United States, directed to the President of the Senate. The President of the Senate shall, in the presence of the Senate and House of Representatives, open all the certificates, and the votes shall then be counted. The person having the greatest number of votes shall be the President, if such number be a majority of the whole number of electors appointed, and if there be more than one who have such a majority, and have an equal number of votes, then the House of Representatives shall immediately choose by ballot one of them for President; and if no person have a majority, then from the five highest on the list the said House shall in like manner choose the President. But in choosing the President, the vote shall be taken by States, the representation from each State having one vote. A quorum, for this purpose, shall consist of a member or members from two-thirds of the States, and a majority of all the States shall be necessary to a choice. In every case, after the choice of the President, the person having the greatest number of votes of the electors shall be the Vice President. But if there should remain two or more who have equal votes,

the Senate shall choose from them by ballot the Vice President.*

4. The Congress may determine the time of choosing the electors and the day on which they shall give their votes, which day shall be the same throughout the United States.

5. No person except a natural born citizen, or a citizen of the United States at the time of the adoption of this Constitution, shall be eligible to the office of President; neither shall any person be eligible to that office who shall not have attained to the age of thirty-five years and been fourteen years a resident within the United States.

6. In case of the removal of the President from office, or of his death, resignation, or inability to discharge the powers and duties of the said office, the same shall devolve on the Vice President, and the Congress may by law provide for the case of removal, death, resignation, or inability, both of the President and Vice President, declaring what officer shall then act as President, and such officer shall act accordingly until the disability be removed or a President shall be elected.

7. The President shall, at stated times, receive for his services a compensation which shall neither be increased nor diminished during the period for which he shall have been elected, and he shall not receive within that period any other emolument from the United States, or any of them.

8. Before he enter on the execution of his office he shall take the following oath or affirmation.

"I do solemnly swear (or affirm) that I will faithfully execute the office of President of the United States, and will, to the best of my ability, preserve, protect, and defend the Constitution of the United States."

Section 2—(President to be Commander-in-Chief. He may require opinions of Cabinet Officers, etc., may pardon. Treaty-making power. Nomination of certain officers. When President may fill vacancies.)

1. The President shall be Commander-in-Chief of the Army and Navy of the

*This clause is superseded by Article XII., Amendments.

United States, and of the militia of the several States when called into the actual service of the United States; he may require the opinion, in writing, of the principal officer in each of the executive departments upon any subject relating to the duties of their respective offices, and he shall have power to grant reprieves and pardons for offences against the United States except in cases of impeachment.

2. He shall have power, by and with the advice and consent of the Senate to make treaties, provided two-thirds of the Senators present concur; and he shall nominate and by and with the advice and consent of the Senate shall appoint ambassadors, other public ministers and consuls, judges of the Supreme Court, and all other officers of the United States whose appointments are not herein otherwise provided for, and which shall be established by law: but the Congress may by law vest the appointment of such inferior officers as they think proper in the President alone, in the courts of law, or in the heads of departments.

3. The President shall have power to fill up all vacancies they may happen during the recess of the Senate by granting commissions, which shall expire at the end of their next session.

Section 3—(President shall communicate to Congress. He may convene and adjourn Congress, in case of disagreement, etc. Shall receive Ambassadors, execute laws, and commission officers.)

He shall from time to time give to the Congress information of the state of the Union, and recommend to their consideration such measures as he shall judge necessary and expedient; he may, on extraordinary occasions, convene both Houses, or either of them, and in case of disagreement between them with respect to the time of adjournment, he may adjourn them to such time as he shall think proper; he shall receive ambassadors and other public ministers; he shall take care that the laws be faithfully executed, and shall commission all the officers of the United States.

Section 4—(All civil offices forfeited for certain crimes.)

The President, Vice-President, and all civil officers of the United States shall be

removed from office on impeachment for and conviction of treason, bribery or other high crimes and misdemeanors.

ARTICLE III.

Section 1—(Judicial powers. Tenure. Compensation.)

The judicial power of the United States shall be vested in one Supreme Court, and in such inferior courts as the Congress may from time to time ordain and establish. The judges, both of the Supreme and inferior courts, shall hold their offices during good behavior, and shall at stated times receive for their services a compensation which shall not be diminished during their continuance in office.

Section 2—(Judicial power; to what cases it extends. Original jurisdiction of Supreme Court. Appellate. Trial by jury, etc. Trial, where.)

1. The judicial power shall extend to all cases in law and equity arising under this Constitution, the laws of the United States, and treaties made, or which shall be made, under their authority; to all cases affecting ambassadors, other public ministers and consuls; to all cases of admiralty and maritime jurisdiction; to controversies to which the United States shall be a party; to controversies between two or more States, between a State and citizens of another State, between citizens of different States, between citizens of the same State claiming lands under grants of different States, and between a State, or the citizens thereof, and foreign states, citizens, or subjects.

2. In all cases affecting ambassadors, other public ministers, and consuls, and those in which a State shall be party, the Supreme Court shall have original jurisdiction. In all the other cases before mentioned the Supreme Court shall have appellate jurisdiction both as to law and fact, with such exceptions and under such regulations as the Congress shall make.

3. The trial of all crimes, except in cases of impeachment, shall be by jury, and such trial shall be held in the State where the said crimes shall have been committed; but when not committed within any State the trial shall be at such place or places as the Congress may by law have directed.

Section 3—(Treason defined. Proof of. Punishment of.)

1. Treason against the United States shall consist only in levying war against them, or in adhering to their enemies, giving them aid and comfort. No person shall be convicted of treason unless on the testimony of two witnesses to the same overt act, or on confession in open court.

2. The Congress shall have power to declare the punishment of treason, but no attainder of treason shall work corruption of blood or forfeiture except during the life of the person attained.

ARTICLE IV.

Section 1—(Each State to give credit to the public acts, etc., of every other State.)

Full faith and credit shall be given in each State to the public acts, records, and judicial proceedings of every other State. And the Congress may by general laws prescribe the manner in which such acts, records, and proceedings shall be proved, and the effect thereof.

Section 2—(Privileges of citizens of each State. Fugitives from justice to be delivered up. Persons held to service having escaped, to be delivered up.)

1. The citizens of each State shall be entitled to all privileges and immunities of citizens in the several States.

2. A person charged in any State with treason, felony, or other crime, who shall flee from justice, and be found in another State, shall, on demand of the Executive authority of the State from which he fled, be delivered up, to be removed to the State having jurisdiction of the crime.

3. No person held to service or labor in one State, under the laws thereof, escaping into another shall in consequence of any law or regulation therein, be discharged from such service or labor, but shall be delivered up on claim of the party to whom such service or labor may be due.

Section 3—(Admission of new States. Power of Congress over territory and other property.)

1. New States may be admitted by the Congress into this Union; but no new State shall be formed or erected within

the jurisdiction of any other State, nor any State be formed by the junction of two or more States, or parts of States, without the consent of the Legislatures of the States concerned, as well as of the Congress.

2. The Congress shall have power to dispose of and make all needful rules and regulations respecting the territory or other property belonging to the United States; and nothing in this Constitution shall be so construed as to prejudice any claims of the United States, or of any particular State.

Section 4—(Republican form of government guaranteed. Each State to be protected.)

The United States shall guarantee to every State in this Union a Republican form of government, and shall protect each of them against invasion, and, on application of the Legislature, or of the Executive (when the Legislature cannot be convened), against domestic violence.

ARTICLE V.

(Constitution: how amended. Proviso.)

The Congress, whenever two-thirds of both Houses shall deem it necessary, shall propose amendments to this Constitution, or, on the application of the Legislatures of two-thirds of the several States, shall call a convention for proposing amendments, which, in either case, shall be valid to all intents and purposes, as part of this Constitution, when ratified by the Legislatures of three-fourths of the several States, or by conventions in three-fourths thereof, as the one or the other mode of ratification may be proposed by the Congress; provided that no amendments which may be made prior to the year one thousand eight hundred and eight shall in any manner affect the first and fourth clauses in the Ninth Section of the First Article; and that no State, without its consent, shall be deprived of its equal suffrage in the Senate.

ARTICLE VI.

(Certain debts, etc., declared valid. Supremacy of Constitution treaties, and laws of the United States. Oath to support Constitution, by whom taken. No religious test.)

1. All debts contracted and engage-

ments entered into before the adoption of this Constitution shall be as valid against the United States under this Constitution as under the Confederation.

2. This Constitution and the laws of the United States which shall be made in pursuance thereof and all treaties made, or which shall be made, under the authority of the United States, shall be the supreme law of the land, and the judges in every State shall be bound thereby, anything in the Constitution or laws of any State to the contrary notwithstanding.

3. The Senators and Representatives before mentioned, and the members of the several State Legislatures, and all executive and judicial officers, both of the United States and of the several States, shall be bound by oath or affirmation to support this Constitution; but no religious test shall ever be required as a qualification to any office or public trust under the United States.

ARTICLE VII.

(What ratification shall establish Constitution.)

The ratification of the Conventions of nine States shall be sufficient for the establishment of this Constitution between the States so ratifying the same.

AMENDMENTS.

Opposition in and out of Congress to the Constitution, in that it was not sufficiently explicit as to individual and State rights, led to an agreement to submit to the people immediately after the adoption of the Constitution a number of safeguarding amendments.

And so it was that the First Congress, at its first session, at the City of New York, Sept. 25, 1789, adopted and submitted to the States twelve proposed amendments—A Bill of Rights, as it was then and ever since has been popularly called. Ten of these amendments (now commonly known as one to ten inclusive, but in reality three to twelve inclusive) were ratified by the States as follows—New Jersey, Nov. 20, 1789; Maryland, Dec. 19, 1789; North Carolina, Dec. 22, 1789; South Carolina, Jan. 19, 1790; New Hampshire, Jan. 25, 1790; Delaware, Jan. 28, 1790; Pennsylvania, March 10, 1790; New York, March 27, 1790; Rhode Island, June 15, 1790; Vermont, Nov. 3,

1791; Virginia, Dec. 15, 1791. No ratification by Connecticut, Georgia or Massachusetts is on record. These original ten ratified amendments appear in order below as Articles I. to X. inclusive.

The two of the original proposed amendments which were not ratified by the necessary number of States related, the first to apportionment of Representatives; the second, to compensation of members of Congress.

Congress, May 1, 1810, proposed to the States the following Amendment to the Constitution:

"If any citizen of the United States shall accept, claim, receive, or retain any title of nobility or honor, or shall, without the consent of Congress, accept and retain any present, pension, office, or emolument of any kind whatever, from any emperor, king, prince or foreign power, such person shall cease to be a citizen of the United States and shall be incapable of holding any office of trust or profit under them or either of them."

It was ratified by Maryland, Dec. 25, 1810; Kentucky, Jan. 31, 1811; Ohio, Jan. 31, 1811; Delaware, Feb. 2, 1811; Pennsylvania, Feb. 6, 1811; New Jersey, Feb. 13, 1811; Vermont, Oct. 24, 1811; Tennessee, Nov. 21, 1811; Georgia, Dec. 13, 1811; North Carolina, Dec. 23, 1811; Massachusetts, Feb. 27, 1812; New Hampshire, Dec. 10, 1812.

Rejected by New York (Senate), March 12, 1811; Connecticut, May session, 1813; South Carolina, approved by Senate Nov. 28, 1811, reported unfavorably in House and not further considered Dec. 7, 1813; Rhode Island, Sept. 15, 1814.

The amendment failed, not having sufficient ratifications.

Congress, March 2, 1861, proposed to the States the following Amendment to the Constitution:

"No Amendment shall be made to the Constitution which will authorize or give to Congress the power to abolish or interfere, within any State, with the domestic institutions thereof, including that of persons held to labor or service by the laws of said State."

Ratified by Ohio, March 13, 1861; Maryland, Jan. 10, 1862; Illinois (convention), Feb. 14, 1862. The amendment failed, for lack of a sufficient number of ratifications.

THE TEN ORIGINAL AMENDMENTS.

(They were declared in force December 15, 1791.)

ARTICLE I.

Religious Establishment Prohibited Freedom of Speech, of the Press, and Right to Petition.

Congress shall make no law respecting an establishment of religion, or prohibiting the free exercise thereof; or abridging the freedom of speech or of the press; or the right of the people peaceably to assemble and to petition the Government for a redress of grievances.

ARTICLE II.

Right to Keep and Bear Arms.

A well-regulated militia being necessary to the security of a free State, the right of the people to keep and bear arms shall not be infringed.

ARTICLE III.

No Soldier to Be Quartered in Any House, Unless, Etc.

No soldier shall, in time of peace, be quartered in any house without the consent of the owner, nor in time of war but in a manner to be prescribed by law.

ARTICLE IV.

Right of Search and Seizure Regulated.

The right of the people to be secure in their persons, houses, papers and effects, against unreasonable searches and seizures, shall not be violated, and no warrants shall issue but upon probable cause, supported by oath or affirmation, and particularly describing the place to be searched, and the persons or things to be seized.

ARTICLE V.

Provisions Concerning Prosecution, Trial and Punishment.—Private Prop- erty Not to Be Taken for Public Use, Without Compensation.

No person shall be held to answer for a capital or other infamous crime unless on a presentment or indictment of a Grand Jury, except in cases arising in the land or naval forces, or in the militia, when in actual service, in time of war or public danger; nor shall any person be subject for the same offense to be twice put in jeop-

ard of life or limb; nor shall be compelled in any criminal case to be a witness against himself, nor be deprived of life, liberty, or property, without due process of law; nor shall private property be taken for public use without just compensation.

ARTICLE VI.

Right to Speedy Trial, Witnesses, Etc.

In all criminal prosecutions, the accused shall enjoy the right to a speedy and public trial, by an impartial jury of the State and district wherein the crime shall have been committed, which districts shall have been previously ascertained by law, and to be informed of the nature and cause of the accusation; to be confronted with the witnesses against him; to have compulsory process for obtaining witnesses in his favor, and to have the assistance of counsel for his defense.

ARTICLE VII.

Right of Trial by Jury.

In suits at common law, where the value in controversy shall exceed twenty dollars, the right of trial by jury shall be preserved, and no fact tried by a jury shall be otherwise re-examined in any court of the United States than according to the rules of the common law.

ARTICLE VIII.

Excessive Bail or Fines and Cruel Punishment Prohibited.

Excessive bail shall not be required, nor excessive fines imposed, nor cruel and unusual punishments inflicted.

ARTICLE IX.

Rule of Construction of Constitution.

The enumeration in the Constitution of certain rights shall not be construed to deny or disparage others retained by the people.

ARTICLE X.

Rights of States Under Constitution.

The powers not delegated to the United States by the Constitution, nor prohibited by it to the States, are reserved to the States respectively, or to the people.

ARTICLE XI.

Judicial Powers Construed.

The following amendment was proposed to the Legislatures of the several States

by the Third Congress on the 5th of March, 1794, and was declared to have been ratified in a message from the President to Congress, dated Jan. 8, 1798.

The judicial power of the United States shall not be construed to extend to any suit in law or equity, commenced or prosecuted against one of the United States, by citizens of another State, or by citizens or subjects of any foreign state.

ARTICLE XII.

Manner of Choosing President and Vice-President.

The following amendment was proposed to the Legislatures of the several States by the Eighth Congress on the 12th of December, 1803, and was declared to have been ratified in a proclamation by the Secretary of State, dated September 25, 1804. It was ratified by all the States except Connecticut, Delaware, Massachusetts, and New Hampshire.

The Electors shall meet in their respective States, and vote by ballot for President and Vice-President, one of whom at least shall not be an inhabitant of the same State with themselves; they shall name in their ballots the person voted for as President, and in distinct ballots the person voted for as Vice-President; and they shall make distinct list of all persons voted for as President, and of all persons voted for as Vice-President, and of the number of votes for each, which list they shall sign and certify, and transmit, sealed, to the seat of the Government of the United States, directed to the President of the Senate; the President of the Senate shall, in the presence of the Senate and House of Representatives, open all the certificates and the votes shall then be counted; the person having the greatest number of votes for President shall be the President, if such number be a majority of the whole number of Electors appointed; and if no person have such majority, then from the persons having the highest number, not exceeding three, on the list of those voted for as President, the House of Representatives shall choose immediately, by ballot, the President. But in choosing the President, the votes shall be taken by States, the representation from each State having one vote; a quorum for this purpose shall consist of a member, or members from two-thirds of the States,

and a majority of all the States shall be necessary to a choice. And if the House of Representatives shall not choose a President, whenever the right of choice shall devolve upon them, before the fourth day of March next following, then the Vice-President shall act as President, as in the case of the death or other constitutional disability of the President. The person having the greatest number of votes as Vice-President shall be the Vice-President if such number be a majority of the whole number of Electors appointed, and if no person have a majority, then from the two highest numbers on the list the Senate shall choose the Vice-President; a quorum for the purpose shall consist of two-thirds of the whole number of Senators, and a majority of the whole number shall be necessary to a choice. But no person constitutionally ineligible to the office of President shall be eligible to that of Vice-President of the United States.

ARTICLE XIII.

Slavery Abolished.

The following amendment was proposed to the Legislatures of the several States by the Thirty-eighth Congress on the 1st of February, 1865, and was declared to have been ratified in a proclamation by the Secretary of State dated December 18, 1865. It was rejected by Delaware and Kentucky; was conditionally ratified by Alabama and Mississippi; and Texas took no action.

1. Neither slavery nor involuntary servitude, except as a punishment for crime whereof the party shall have been duly convicted, shall exist within the United States, or any place subject to their jurisdiction.

2. Congress shall have power to enforce this article by appropriate legislation.

ARTICLE XIV.

Citizenship Rights Not to Be Abridged.

The following, popularly known as the Reconstruction Amendment, was proposed to the Legislatures of the several States by the Thirty-ninth Congress on the 16th of June, 1866, and was declared to have been ratified in a proclamation by the Secretary of State, dated July 23, 1868. The amendment got the support of 23 Northern States; it was rejected by Delaware, Ken-

tucky, Maryland, and 10 Southern States. California took no action. Subsequently it was ratified by the 10 Southern States.

1. All persons born or naturalized in the United States, and subject to the jurisdiction thereof, are citizens of the United States and of the State wherein they reside. No State shall make or enforce any law which shall abridge the privileges or immunities of citizens of the United States; nor shall any State deprive any person of life, liberty, or property without due process of law, nor deny to any person within its jurisdiction the equal protection of the laws.

Apportionment of Representatives in Congress.

2. Representatives shall be apportioned among the several States according to their respective numbers, counting the whole number of persons in each State excluding Indians not taxed. But when the right to vote at any election for the choice of Electors for President and Vice-President of the United States, Representatives in Congress, the executive and judicial officers of a State, or the members of the Legislature thereof, is denied to any of the male inhabitants of such State, being of twenty-one years of age, and citizens of the United States, or in any way abridged, except for participation in rebellion or other crime, the basis of representation therein shall be reduced in the proportion which the number of such male citizens shall bear to the whole number of male citizens twenty-one years of age in such State.

Power of Congress to Remove Disabilities of United States Officials for Rebellion.

3. No person shall be a Senator or Representative in Congress, or Elector of President and Vice-President or holding any office, civil or military, under the United States, or under any State, who, having previously taken an oath, as a member of Congress, or as an officer of the United States, or as a member of any State Legislature or as an executive or judicial officer of any State, to support the Constitution of the United States, shall have engaged in insurrection or rebellion against the same, or given aid and comfort to the enemies thereof. But Congress may, by a vote of two-thirds of each House, remove such disability.

What Public Debts Are Valid.

4. The validity of the public debt of the United States, authorized by law, including debts incurred for payment of pensions and bounties for services in suppressing insurrections and rebellion, shall not be questioned. But neither the United States nor any State shall assume or pay any debt or obligation incurred in aid of insurrection or rebellion against the United States, or any claim for the loss or emancipation of any slave; but all such debts, obligations, and claims shall be held illegal and void.

5. The Congress shall have power to enforce by appropriate legislation the provisions of this article.

ARTICLE XV.

Equal Rights for White and Colored Citizens.

The following amendment was proposed to the Legislatures of the several States by the Fortieth Congress on the 27th of February, 1869, and was declared to have been ratified in a proclamation by the Secretary of State, dated March 30, 1870. It was not acted on by Tennessee: it was rejected by California, Delaware, Kentucky, Maryland, and Oregon, ratified by the remaining 30 States. New York rescinded its ratification January 5, 1870. New Jersey rejected it in 1870, but ratified it in 1871.

1. The right of the citizens of the United States to vote shall not be denied or abridged by the United States, or by any State on account of race, color, or previous condition of servitude.

2. The Congress shall have power to enforce the provisions of this article by appropriate legislation.

ARTICLE XVI.

Income Taxes Authorized.

The following amendment was proposed to the Legislatures of the several States by the Sixty-first Congress on the 12th day of July, 1909, and was declared to have been ratified in a proclamation by the Secretary of State, dated February 25, 1913. The income tax amendment was ratified by all the States except Connecticut, Florida, Pennsylvania, Rhode Island, Utah, and Virginia.

The Congress shall have power to lay and collect taxes on incomes, from what-

ever sources derived, without apportionment among the several States, and without regard to any census or enumeration.

ARTICLE XVII.

United States Senators to Be Elected by Direct Popular Vote.

The following amendment was proposed to the Legislatures of the several States by the Sixty-second Congress on the 16th day of May, 1912, and was declared to have been ratified in a proclamation by the Secretary of State, dated May 31, 1913. It got the vote of all the States except Alabama, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, Rhode Island, South Carolina, Utah, and Virginia.

1. The Senate of the United States shall be composed of two Senators from each State, elected by the people thereof, for six years; and each Senator shall have one vote. The electors in each State shall have the qualifications requisite for electors of the most numerous branch of the State Legislatures.

Vacancies in Senatorships, When Governor May Fill by Appointment.

2. When vacancies happen in the representation of any State in the Senate, the executive authority of such State shall issue writs of election to fill such vacancies: Provided, That the Legislature of any State may empower the Executive thereof to make temporary appointment until the people fill the vacancies by election as the Legislature may direct.

3. This amendment shall not be so construed as to affect the election or term of any Senator chosen before it becomes valid as part of the Constitution.

ARTICLE XVIII.

Liquor Prohibition Amendment.

The following amendment was proposed to the Legislatures of the several States by the Sixty-fifth Congress, December 18, 1917; and on January 29, 1919, the United States Secretary of State proclaimed its adoption by 36 States, and declared it in effect on January 16, 1920.

The amendment ultimately was adopted by all the States except Connecticut and Rhode Island.

Enforcement of the National Prohibition Act was in effect at 12 P. M., January

16, 1920, except as to certain sections of Title II., wherein other dates were specified.

Early in 1920, the validity of the Eighteenth Amendment was upheld by the Supreme Court of the United States, in suits to void, brought by the State of Rhode Island and New Jersey, and by various brewers and distillers.

1. After one year from the ratification of this article the manufacture, sale, or transportation of intoxicating liquors within, the importation thereof into, or the exportation thereof from the United States, and all territory subject to the jurisdiction thereof for beverage purposes is hereby prohibited.

2. The Congress and the several States shall have concurrent power to enforce this article by appropriate legislation.

3. This article shall be inoperative unless it shall have been ratified as an amendment to the Constitution by the Legislatures of the several States, as provided in the Constitution, within seven years from the date of the submission hereof to the States by the Congress.

ARTICLE XIX.

Giving Nation-wide Suffrage to Women.

The following amendment was proposed to the Legislatures of the several States by the Sixty-fifth Congress, having been adopted by the House of Representatives, May 21, 1919, and by the Senate, June 4, 1919. On August 26, 1920, the United States Secretary of State proclaimed it in effect, having been adopted (June 10, 1919-August 18, 1920) by three-quarters of the States. The Tennessee House, August 31, rescinded its ratification, 47 to 24.

1. The right of citizens of the United States to vote shall not be denied or abridged by the United States or by any State on account of sex.

2. Congress shall have power, by appro-

priate legislation, to enforce the provisions of this article.

THE PROPOSED ARTICLE XX.

Federal Regulation of Child Labor.

The following amendment was proposed to the Legislatures of the several States by the Sixty-eighth Congress, having been adopted as a joint resolution by the House of Representatives (297 to 69) on April 26, 1924, and by the Senate (61 to 23) on June 2, 1924.

Section 1—The Congress shall have power to limit, regulate, and prohibit the labor of persons under eighteen years of age.

Section 2—The power of the several States is unimpaired by this article except that the operation of State laws shall be suspended to the extent necessary to give effect to legislation enacted by the Congress.

Five states have adopted the Amendment—Arizona, Arkansas, California, Montana, and Wisconsin.

Six states have taken no definite action—Alabama, Illinois, Mississippi, New Jersey, New York, and Rhode Island.

It has been ratified by one House of the Legislature in New Mexico, and Nevada.

It has been rejected by both Houses in Connecticut, Delaware, Florida, Georgia, Indiana, Kansas, Kentucky, Maine, Maryland, Massachusetts, Minnesota, Missouri, New Hampshire, North Carolina, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Vermont, Virginia, Washington, West Virginia.

The amendment was rejected by one House in Idaho, Louisiana, Michigan, Nebraska, North Dakota, Ohio, Oklahoma, Oregon, and Wyoming.

A vote was indefinitely postponed by one House, in Colorado and Iowa.

—*The World Almanac.*

A \$100,000,000 FLY

Few insects have such records for destructiveness as the Hessian fly whose activities have cost the country as much as \$100,000,000 in a single year, the United States Department of Agriculture's records show. At least eight serious outbreaks have occurred over the northeast-

ern one-third of the United States within the last 45 years. Local activity is evident almost every year somewhere in that large territory or in limited areas on the Pacific coast. Farmers' Bulletin 1627-F, The Hessian Fly and How Losses from It Can Be Avoided, is free to anyone requesting it.

ECONOMIC PROGRESS OF FINLAND

The marked progress made by Finland since the establishment of that country's independence twelve years ago, is revealed in an economic review just released by the United States Department of Commerce.

The new political and commercial orientation resulting from the war and the disorganization of the Russian market, brought to Finland problems of the most vital consequence. A most complete reorganization was necessitated in Government finance, domestic industry, and foreign trade. The degree to which this has been accomplished within a relatively short period is a notable achievement and according to the report justifies a confident view of the future prosperity of the country.

The participation of the United States has more than kept pace with the steadily growing foreign trade of Finland in recent years. During the five-year period from 1924 to 1928, total imports of Finland expanded from \$118,358,000 to \$201,925,000. During this time the American share of Finland's import trade increased from \$15,795,000, or 13.3 per cent of the total, to \$29,716,000, or 14.7 per cent. In the last three years of this period the United States ranked second as a source of Finland's imports.

The United States also improved as an outlet for Finnish exports during the five-year period reviewed. Of the more than \$157,000,000 worth of goods exported by Finland in 1928, 6½ per cent, or \$10,294,000, represented shipments to the American market.

Finland's timber resources constitute the mainstay of its export trade, the survey shows. Although some raw timber is exported, the bulk of this commodity leaves the country in the form of various products of the highly developed woodworking industry. Shipments of wood and paper products account for approximately four-fifths of the country's exports. Imports into Finland include a large number of commodities entering into general consumption, such as coffee, sugar, wheat and rye flour. The cotton industry is, of course, entirely dependent on imported raw materials and the same is true to a large extent of the woolen industry.

Practically half of Finland's trade both import and export, is with Great Britain and Germany. The United States and Sweden contribute nearly half of remaining imports, while the bulk of remaining exports is taken by Holland, Belgium, France, the United States and Russia.

ECUADOR HIGHWAYS

"I recently motored over the improved north and south highway in Ecuador," said R. C. Gill to a representative of the Pan American Union. "The road connects Quito and Riobamba, a distance of about 140 miles, and provides excellent motor facilities for those cities and the towns that lie along the route. The hard clay and gravel roadbed is in good condition, the scenery en route is spectacular and the climate is ideal."

The speaker referred to a section of road that forms a part of the Pan American Highway which is gradually linking the American nations. Another interesting fact for the prospective motorist in Ecuador is the statement that there are three good hotels located on this highway. One is at Quito, another at Latacinga and the third at Riobamba. As in the United States, many people in Ecuador who for-

merly patronized the railroads are now traveling by automobile. The rail trip between Quito and Riobamba consumes a full day. By motor the time is reduced to about five hours of rather leisurely travel. The hire of an automobile for the trip including chauffeur, costs about \$25.00; for a seat in a machine with other persons one need pay only about \$5.00. Motor busses also are being operated over the Quito-Riobamba route but they are used largely for freight and are patronized by the laboring classes only. Well-to-do citizens travel in their own cars.

Another road in Ecuador which is drawing more motorists is that between Riobamba and Baños. The latter town lies on the eastern slopes of the Andes in a region where several large plantations have been recently started by Americans.

THE INTER-AMERICAN HIGHWAY

SPEEDED BY OUR ENGINEERS

A field office to help Central American countries lay out the route of the proposed inter-American highway is being opened in Panama City by the Bureau of Public Roads of the U. S. Department of Agriculture. It will be operated by Thomas A. Forbes and D. Tucker Brown, senior highway engineers, and Marcel J. Busard, assistant highway engineer.

An appropriation of \$50,000 by Congress makes this cooperation with Central American countries possible to

speed work on the international highway.

The entire route through Mexico has been mapped and much of the road completed. In Panama a ferry and a highway near the Pacific entrance of the Panama Canal will be built as the result of a recent act of Congress. An initial appropriation of \$1,000,000 has been authorized for this work, which will fulfill a treaty obligation to provide a convenient and effective permanent crossing of the Canal and the Canal Zone.

ORIGIN OF STATE NAMES

If the United States were to adopt the recent practice in Europe of reviving old place names such as Oslo for Christiania, Nidaros for Trondjhem, Helsinki for Helsingfors, Warszawa for Warsaw, and Praha for Prague, the roster of the forty-eight States would vary in many cases, says the National Geographic Society in recalling the origin of some of the names.

Nineteen States have different original Indian names they could go back to: Alibuma, Arizonac, Quonoktacut, E-dah-hoe, Illini, Ayuhba (Iowa), Kanza, Kantake, Massawadschuash (Massachusetts), Mishigimaw, Missisipi, Missiuri, Ohionhiio, Tanasee, Tejas, Ute, Mishkonsing, Mcheuwomink (Wyoming), Akansea.

"Restoration of old names," continues a bulletin on the subject, "would require Delaware to revert to De la Warr, the name selected in honor of Lord de la Warr. New York was named for the Duke of York, but if origins were to be pushed back as far as possible the Empire State would have to revive the old English form, becoming New Eurewic.

"Illinois serves as an example of States whose present names are pitfalls to the unwary. Persons not familiar with the French adaptation of the original Indian tribe name pronounce the last syllable

'noise.' George Washington, it is said, called the Illinois country Black Island because he thought the French spelled it Ile Noir.

"States whose names would be unchanged by a drive to return of the original forms are: California, Colorado, Florida, Georgia, Indiana, Louisiana, Maine, Maryland, Minnesota, Montana, Nebraska, Nevada, New Hampshire, New Jersey, New Mexico, North Carolina, North Dakota, Oklahoma, Pennsylvania, South Carolina, South Dakota, Virginia, Washington and West Virginia.

"Contrary to United States postal regulations, which prohibit two towns of the same name in one State, there are two Finlands in Minnesota. One spells its name Finland and the other Suomi. Both are named for the European homeland of Finn settlers, the first for the Anglicized name of the new republic and the second for the true native name which Finns themselves use.

"By majority rule, seven Venices, in California, Florida, Illinois, Louisiana, Missouri, Ohio and Utah, can't be wrong. Yet in trying to invoke the charm of the famous Italian port only an Arizona community has copied the true Italian name, Venezia.

MEDALS AWARDED TO FOREIGNERS

It is interesting to know that a large number of medals have been awarded to foreigners for meritorious service to the United States.

The first one struck was of silver, awarded to Lieutenant-Colonel Fleury, one of the young officers of the French army, who obtained leave to enter our service in 1777. In the assault upon Stony Point (July 15th, 1779) he commanded one of the storming parties, was the first to enter the main work, and struck the British flag with his own hands. For this achievement Congress voted him a silver medal. After the Revolution Colonel Fleury went to India, and in 1790 returned to France.

Chevalier John Paul Jones, captain of the French vessel "Bon Homme Richard," though a foreigner, was for some time in the service of the colonial government. By Act of Congress in 1787, he was awarded a gold medal in commemoration of his capture of the "Serapis," eight years before, off Flamborough Head, Yorkshire, England. A gold medal, known as the diplomatic medal, dedicated "To Peace and Commerce," and intended for presentation to distinguished diplomats who were assigned to our government and marked their stay with us by acts of good will, was limited to two issues. One of these was awarded to Marquis de la Luzerne in 1791; he had shown his friendliness for our people by contracting a loan, on his own responsibility, to relieve the distress of the continental army, in 1780. Count de Monstier, French Minister to the U. S., 1787, was awarded the other in 1791.

Another medal, struck under Act of Congress, March 3, 18447, in silver and gold, was presented to the officers and men on the French, British and Spanish ships of war in the harbor of Vera Cruz, who aided in rescuing officers and seamen of the U. S. brig "Somers," which was capsized and sunk in the Gulf of Mexico, December 10, 1846. Medals were also awarded to three shipmasters, Creighton, Low and Stouffer, who, in December, 1853, at great risk to themselves and their ship, rescued about five hundred Americans from the sinking steamship "San Francisco," but it is by no means certain

that Low and Stouffer were foreigners. Capt. Creighton was a Glasgow man. By Act of Congress, May 11th, 1858, a medal was given to Dr. Frederick Henry Rose, the British assistant naval-surgeon, for his services in behalf of the fever-stricken "Susquehannah," in April of the same year. A gold medal was ordered by the Department of State, and presented to the three principal envoys who came to the United States with the Japanese Embassy in May, 1860; the subordinate members of the Embassy received duplicates in copper. This medal bears a portrait of James Buchanan, then President of the United States.

October 8th, 1782, a medal was struck and a few copies given to sundry foreign notables who were interested in our infant republic, to celebrate the treaty of Amity and Commerce between the United States and the United Netherlands; another bearing date April 19th, 1782, but issued at about the same time, commemorated the acknowledgment of the independence and integrity of the United States as a Republic, by the government of the United Netherlands. Another medal struck the same year, though not strictly conferred upon by any one of the United States, was minted and distributed by Benjamin Franklin in honor of the achievement of American liberty. Copies in gold, silver and copper were sent to the King and Queen of France, the Grand Master of Malta, Sir William Jones, and other eminent foreigners. While eighty-six medals in all have been struck since the foundation of the Government of the United States, only three of them commemorate episodes of the late war of Rebellion. One to General Grant for his victories, one to Cornelius Vanderbilt for patriotic generosity, and, at the close of the war, one to George Foster Robinson for saving the life of Mr. Seward, Secretary of State.

The "Medal of Honor," for the army was first established as a reward for military service by Act of Congress, July 22, 1862. A long list is published of those who won this medal, and of course the list must contain the names of many foreigners who enlisted during the Rebellion.

U. S. FORESTRY DEVELOPMENT

John Quincy Adams was our representative at the Russian Court in 1811. He spent some time in England. He knew the term "Supremacy of the Seas." He knew that live oak timber was abundant in Florida. He knew what Russia and England were doing. He knew why!

In 1819 Mr. Adams became Secretary of State when negotiations were completed with Spain for the acquisition of Florida. In 1825 Mr. Adams became President and out of his knowledge of conditions at home and abroad, and out of a motion in Congress sponsored by a gentleman from Florida, came the first national effort in America at reforestation and forest management.

The little island of Santa Rosa off Pensacola was the scene, and Colonel White, the Congressional Delegate from Florida, sponsored the motion. As a result of this new policy, plantations of live oak acorns were made, fire lanes constructed, wardens appointed, patrols established and improvement cuttings carried on for the elimination of weed trees. All in the State of Florida and all over one hundred years ago.

Though administration of the national forests represents the greatest single activity of the government in forestry, government forest work had its real beginning as far back as 1876, with the appointment by the Department of Agriculture of a special agent to study the general forest conditions.

It is interesting to note the legislation providing for this special agent was secured only as a rider through an appropriation for the distribution of seeds.

In 1881 a division of forestry was created in the department, but it received only a small appropriation and could be little more than a bureau of information and advice. This bureau had nothing to do with the forests on the public domain. Nothing had ever been done to protect them and during the eighth decade of the last century it began to look as though they were to eventually be destroyed by fire and reckless cutting.

Congress, therefore, in 1891, conferred upon the president the right to establish forest reservations, and on March 30,

1891, President Harrison created the Yellowstone National Park Land Reserve. This act merely set aside forest lands in reserve. It contained no provision for their protection or development. Under it more forest reservations were created by President Harrison and President Cleveland. The reserves were placed under the jurisdiction of the General Land Office.

Under the act of June 4, 1897, Congress outlined a system of organization and management for the forest reserves and placed their administration under the secretary of the interior. The rules and regulations for administering the reserves were formulated by the commissioner of the General Land Office, and the Geological Survey of the Department of the Interior was charged with surveying and mapping them.

In 1901 the division of forestry of the Department of Agriculture was raised to the rank of bureau, and Gifford Pinchot was made its chief.

The early years are notable for three outstanding accomplishments—the establishment of the Forest Products Laboratory which opened June 4, 1910; the passage of the Weeks' law March 1, 1911, for the purchase of land for the national forests in the Southern Appalachians; and a definite beginning of an effort looking toward the formation of a national forest policy.

On July 1, 1914, District 7 was created. On June 1, 1915, the Branch of Research was formed and all research activities of the Service put under it.

When the United States entered the world war, the Forest Service, together with the lumber industry, raised and sent to France two regiments of forest engineers, the Tenth and the Twentieth. The Service gave 446 men to the army and navy besides many others who served in the war and navy departments in civilian capacity although employed in war industry.

Early in 1920 Col. Graves resigned, and on May 1 Col. Greeley took charge. That same year "Forest Protection Week," later changed "American Forest Week," was first observed. In 1920, too, the office of the editor became the branch of public

relations. The next year the Alaskan National Forests were removed from District 6 and put under District 8, with headquarters at Juneau, Alaska.

Early in 1921 occurred the windstorm that destroyed six billion feet of giant Douglas fir timber on the Olympic peninsula in Washington, making a gigantic fire trap of a territory of over 250 square miles. To insure the safety of this area, the Forest Service, the state of Washington, and private owners cooperated in the most elaborate intensive protection ever undertaken in the United States, if not in the whole world.

The next year saw the establishment of the first regional experiment stations, the Southern at New Orleans and the Appalachian at Asheville.

Probably the outstanding forestry

achievement of the post-war period is the passing of the Clarke-McNary Act of April 23, 1924. This is conceded the greatest forward step in forestry in America, since the passage of the Weeks' Act in 1911.

Other important features of legislation which have been enacted since that time are the McNary-Woodruff Act appropriating funds to be expended for the purchase of national forest land and the McNary Act, May 27, 1928, establishing a ten-year program for the expansion of forest research.

In 1926 the informational and educational work of the service was combined with the Clarke-McNary work in the branch of public relations.

On May 1, 1928, Col. Greeley resigned and Maj. Stuart became Forester.—*Forestry News Digest*.

REFORESTATION IN 1929

Forest planting by all the principal agencies engaged in the work of reforestation in the United States last year restored to tree growth a total of 111,175 acres, records just completed by the Forest Service, U. S. Department of Agriculture, show.

The total acreage set out in young forest trees in 1929 included 107,557 acres in the continental United States, 2,084 acres in Hawaii, and 1,534 acres in Porto Rico. Reforestation activities included the planting of 31,430 acres by 21 States and two Territories; 5,920 acres by municipalities; 25,088 acres by industrial organizations; 539 acres by schools and colleges; and 1,516 acres by other organizations. Plantings by farmers for the extension or improvement of farm woodlots and windbreaks amounted to 24,825 acres; and plantings by other individuals, 3,650 acres. The U. S. Forest Service planted 18,207 acres of land on national forests in 1929.

Michigan, with 27,820 acres restored to tree growth, led the States last year in total acreage planted to forests. New York ranked second with 21,135; and Louisiana third with 10,583 acres. Other States which ranked high in forest-planting ac-

tivities were Pennsylvania, with 6,318 acres; Washington, 4,400 acres; Massachusetts, 3,938 acres; Ohio, 3,428 acres; and California, 3,023 acres.

Industrial forest plantings in 1929 included 10,060 acres planted by pulp and paper companies; 8,732 acres by lumber companies; 3,189 acres by water and power companies; 1,561 acres by mining companies; 100 acres by railroad companies; and 1,446 acres by other industrial organizations.

To the end of the calendar year 1929, the cumulative total of all forest planting in the United States of which the Forest Service has record was 1,653,308 acres. This included 274,385 acres of national forest land planted by the Federal Government; 200,553 acres by States; 46,282 acres by municipalities; 193,262 acres by industrial organizations; 16,335 acres by other organizations; 5,215 by schools and colleges; and 917,276 acres by farmers and other individuals. In cumulative acreage planted, Iowa led with 242,260 acres; Nebraska was second with 219,088 acres; Kansas third with 201,190 acres; and New York fourth with 183,369 acres.

FOREST SERVICE REVIEWS 25 YEARS

Marked expansion in the public use of the National Forests and in the protection and development of the forest resources was noted in a review of the growth of the Government's forestry work in the last quarter century, issued by the Forest Service, U. S. Department of Agriculture.

When the Forest Service took charge of the old-time "Forest Reserves" in 1905, they numbered 60 with an area of approximately 59 million acres. The area is now 160 million acres, embraced in 150 National Forests.

In 25 years of administration the work of physical development of the National Forests has progressed continuously. In 1905 there were no fire towers or lookout stations. To-day, 831 are maintained. A total of 1,186 public camp grounds have been improved in the 25-year period. Since 1907 the mileage of National Forest roads has been extended from 330 to 16,730. Forest trails have increased from 6,644 to 47,175 miles. Mileage of telephone line built for fire protection and administration purposes increased from 539 to 35,926.

Receipts of the "Forest Reserves" in 1905 amounted to \$85,600, all for timber sold. Receipts last year totaled \$6,299,802. Of this more than \$4,000,000 was from the sale of timber, to be cut under Forest Service supervision on a sustained or continuous "crop" basis.

The appropriation for the Forest Service for the fiscal year 1905 was \$910,276. Funds available for Forest Service work during the current fiscal year amounted to more than \$24,000,000 of which about \$11,000,000 is for extending and improving the National Forest road and trail system and for other National Forest improvements. Approximately \$1,400,000 is for cooperation with the States in giving fire protection aid to private forest lands. About \$1,400,000, representing 25 per cent of the National Forest receipts, is turned over to the States for road and school purposes. Road development and the stabilization of forest-using industries have played no small part in the upbuilding of communities in National Forest regions, in the last 25 years, the Forest Service finds.

Livestock grazed under permit on the National Forests increased from 1,400,000 head in 1905 to 7,914,000 in 1929. Special use permits in force on the National Forests registered a gain in 25 years of more than 1100 per cent—from 300 in 1905 to 33,310 this year.

There was no record of the number of National Forest visitors in 1905. In the latest year for which records are available, 23,000,000 persons visited the forests.

The Forest Service began work in 1905 with 734 employees. The number has increased to 2,710 in the quarter century. The progress of decentralization is indicated by the fact that 268 members of the Service were attached to the Washington headquarters in 1905 as compared with only 197 to-day. This decentralization is in line with the Forest Service policy of administration of the National Forests by field officers on the ground and in close touch with local problems.

The money receipts from National Forest activities in the last six months of 1929 were nearly 10 per cent more than the receipts for the same period of 1928. In this period the nine National Forest districts received a net total of \$3,245,164.03 from timber sales, grazing fees, etc., an increase of \$316,053.96 over the same six months of 1928.

The sale of timber to be cut under Forest Service supervision yielded \$2,405,829.17, nearly three-fourths of the total of receipts. Nearly 1,500,000,000 board feet of timber is now being cut annually on the National Forests, or a little more than 3 per cent of the total cut for the country. The present cut could be materially increased without overcutting the sustained annual yield, says the Forest Service, but for economic reasons it is not the policy to force National Forest timber on the market. Large sales of National Forest timber are made (1) to enable established mills to continue operation, stabilizing communities dependent on them; (2) to prevent depreciation in value of Government timber; (3) to aid development of regions or communities by the establishment of industries and transportation facilities.

Receipts from grazing amounted to \$625,267.99, an increase of nearly \$75,000 over the same half-year of 1928. Special use and water-power permits brought in \$120,168.64 and \$58,042 respectively, increases of \$24,711.52 and \$4,431.20.

The California District, which includes the National Forests of California and southwestern Nevada, had the largest receipts, \$924,830.36, which was more than one-fourth of the total. The North Pacific District, comprising Washington and Oregon, followed with \$636,622.28. The

Rocky Mountain District had receipts totaling \$446,916.42; the Intermountain, \$334,645.25; the Northern, \$327,822.79; the Southwestern, \$276,154.71; the Eastern, \$229,445.75; the Alaska District, \$43,375.57; and the Lake States District, \$23,350.90. These figures are for the last six months of 1929.

Twenty-five per cent of National Forest Receipts is turned over each fiscal year to the counties in which the forests are located, in lieu of taxes, for road building and school development.

EFFICIENCY IN U. S.

The widely heralded efficiency of the United States was measured before the nations of the world in a paper presented to the World Power Conference by F. G. Tryon, of the Brookings Institution and the U. S. Bureau of Mines.

In the United States the production of electricity from coal has become 400 per cent. more efficient than it was in 1902, Mr. Tryon said. Six pounds of coal were required to produce one kilowatt of electrical energy in 1902, 3.3 pounds in 1917, and 1.76 pounds in 1928.

A railroad train runs now 40 per cent. farther on a ton of coal than it did 30 years ago. A ton of steel is made by the consumption of a third less coal and the

manufacture of a barrel of cement requires 20 per cent. less than was needed just 20 years ago.

Progress will continue, Mr. Tryon believes, both through new inventions and through the bringing of average performance closer to the level of what best performance has already proved feasible.

"The most efficient central station," he explained, "requires only nine-tenths of a pound of coal per kilowatt hour, or barely half as much as the average for all stations. The best steam locomotives in use require only 70 pounds of coal per 1,000 gross ton-miles, as against an average of 127 for all locomotives."—*Science Service*.

SOIL EROSION

Erosion continues to wash away the soil resources of the nation. A recent survey of a typical small valley in northeastern Kansas shows that 86 per cent of the land, comprising the greater part of the valley, has lost from 8 to 40 inches of soil since it was cleared 40 years ago, the United States Department of Agriculture reports.

Thirty-four acres had lost an average of 11 inches of soil, 45 acres had lost 18 inches, 10 acres had lost 21 inches, 2½

acres had lost 23 inches and 1½ acres had lost 3¾ feet of soil. The "yardstick" for measuring the losses was found in a few remaining patches of timber, where the soil was as nature originally built it—a mellow, rich silt loam almost black with spongy humus, and capable of producing 75 bushels of corn an acre. Now the land is very much less productive. Much of it is overrun with weeds. In the meantime the washing proceeds.

"SPRINGWOOD" AND "SUMMERWOOD"

It is well known that the growth of a tree in diameter is shown in the so-called "rings" of annual growth. These rings are simply the material that is added around the tree underneath the bark each year. The outer cells, just inside the bark, make up the living, active portion of the tree and each year's product is plainly marked off from that of the preceding year. It is in this manner that the rings are formed.

It is perhaps not so well understood popularly that each ring is made up of two parts: first the inner light-colored portion known as "springwood"; and, second, an outer darker portion known as "summerwood." During the spring months the tree grows faster than it does in the summer and the cells produced at that time are larger and have thinner walls. The summerwood cells have thicker walls, and are smaller. Summerwood, therefore, gets more solid wood substance than springwood and is darker in color. The two parts of the annual ring are much more noticeable in the softwoods—that is, the coniferous trees—than in the hardwoods.

The proportion of springwood to summerwood in softwood lumber has an important effect upon the strength proper-

ties and physical characteristics of the lumber.

In some species the springwood blends into the summerwood and in this condition makes for uniform texture, easier working and a small amount of shrinkage and swelling of the lumber. In other softwoods the transition from springwood to summerwood is more abrupt, the proportion of summerwood is larger and the wood is stronger, and the two parts of the annual ring can be seen clearly.

Owing to the importance of the composition of lumber with respect to the varying proportions of springwood and summerwood, the National Lumber Manufacturers Association, Washington, D. C., has issued a leaflet—No. 9—in its LUMBER FACTS series that fully treats of this subject. An earlier leaflet in the series, LUMBER FACTS No. 4, dealt with the subject of softwoods and hardwoods in general, the relation of softwood to hardwood and the subject of annual growth rings. These two leaflets present in compact, easily understandable form the most essential facts which purchasers and users of lumber should know regarding the natural composition of the material.

LARGEST INDIVIDUAL TREE PLANTER

Thomas C. Luther has the reputation of being the largest individual tree planter in the world. He has been reforesting his 10,000 acre estate, planting at the rate of more than a million trees a year. He has suspended reforestation for one year and is devoting his energies to improving

his system of fire protection and forest pest control. There are several thousand acres of mature timber on the property which is being administered under scientific forest principles.—*Forestry News Digest.*

FOOD FROM CACTI

The giant Sahuaro and organ pipe cacti and the smaller organ pipe or pitahaya castus of Arizona produce good crops of delicious fruits used for centuries by Indians for sirups, preserves, and dried food. They bear fruit even after three

years of extreme drought. The United States Department of Agriculture is studying them as a possible article of commerce and a possible crop for utilization in the arid Southwest.

IMPORTED PLANTS

How countless millions of dollars have been added to the wealth of the United States through the introduction of seeds and plants from all parts of the world will be discussed at the Inter-American Conference on Agriculture, Forestry, and Animal Industry, to be held in Washington. The discussion will be led by Knowles A. Ryerson, of the United States Department of Agriculture.

Since the office of foreign plant intro-

duction was created, in 1898, the department has brought to the United States more than 85,000 new plants, many of which have become extremely important. Because of the varied climatic and geographic conditions in the other countries of the two Americas, Mr. Ryerson believes that there is equal, if not greater opportunity for these countries to improve their agriculture through the introduction of new plants.

TO DESTROY POISON IVY

Low-grade kerosene or crude oil, sprayed on the poison ivy vine, suffocates the plant tissues and causes destructive chemical action so that the plant dies. High-grade kerosene is not so good for it volatilizes too rapidly. Best results are obtained in hot weather. If possible, it is

also advisable to cut the stems near the ground and repeat the cutting frequently until the plants are starved. Through lack of foliage, the plant, once it has used up the food stored in the roots, cannot manufacture more food for re-growth.

SURFACE COAL PRODUCTION

While the coal market of the United States has been in the grip of a pronounced depression, the consumption of coal being checked by fuel economy and the competition of oil and water power, the mining of strip coal with power shovels on the surface of the earth has increased 17 fold in the past 15 years compared with a mere 20 per cent. increase in the quantity of coal from underground mines.

Although the increase in strip coal mining has been phenomenal, the 22,000,000 tons of this coal mined last year was only about four per cent. of the quantity produced from under the ground, Scott Turner, director of the U. S. Bureau of Mines, made clear in a report presented before the World Power Conference.

The stripping industry was established during the World War when coal was high. The continued high cost of timber used in underground mines and the decline in surface land values after 1920 helped bring prosperity to the stripping operations in a period of depression. The strip mines also reduced costs and improved the

quality of their product and methods.

"The future of coal stripping in the United States is likely to depend more on the economic competition of other coals than on physical obstacles to stripping," Mr. Turner said. "With the natural obstacles tending to increase and the costs of underground mining tending to decline, it is probably safe to forecast an ultimate equilibrium of stripping and underground costs in which further expansion of stripping will be checkmated by the price competition of underground coal.

"In some sections of the country where the coal beds are approaching exhaustion, such as the Southeast Kansas field, the prospect of further increase seems small. In Illinois, on the other hand, exhaustion of the lands which can be stripped, even with present equipment, is remote. In Indiana there is no prospect of early exhaustion. Also in the lignite and sub-bituminous fields of the Northern Great Plains, the tonnage which can be stripped, if the market conditions warrant, is very large."

—*Science Service.*

ARROW GRASS

POISONOUS TO LIVESTOCK

Hydrocyanic acid, one of the deadliest of poisons, exists in small quantities in arrow grass, *Triglochin maritima*, a plant which has caused the death of many cattle in western Nebraska, Utah, Wyoming, and Nevada. In this country arrow grass, known also as goose grass and sour grass was first observed in salt marshes near the coast, but is also found in salty or alkaline spots near streams and lakes in the interior. This plant is the subject of a bulletin just issued by the U. S. Department of Agriculture, "Arrow Grass as a Stock Poisoning Plant," Technical Bulletin No. 113-T. The bulletin reviews previous mention of the plant as poisonous to livestock, describes the plant, and reports experiments in which it was fed to cattle and sheep in various amounts and in different stages of the plant, from fresh-cut leaves to cured hay.

Arrow grass is a perennial herb, growing to a height of from 6 inches to 2½ feet. It has slender, green, fleshy leaves, rising from a sheathed base. The cross-section of the leaf is approximately semicircular. The flower spikes are slender, the rounded stalks naked below, and the numerous flowers are smooth, small, greenish, and inconspicuous. When a quantity of the green plant is crushed the odor of hydrocyanic acid is distinct.

Symptoms of poisoning by arrow grass include restlessness, suggesting discomfort, and usually a rapid pulse and rapid respiration with relatively little fever. These early symptoms are followed by staggering, more or less complete prostration, and coma in the worst cases. If the

animal survives, recovery is rapid and apparently there are no serious after-effects. The poison works too rapidly to cause marked changes in the organs of the animal.

For cattle the minimum toxic dose causing illness is about 1 per cent of the weight of the animal. About 1.7 per cent is likely to cause death. The corresponding doses for sheep are 1.25 per cent and 2 per cent.

To produce poisoning, says the bulletin, the toxic dose must be eaten in a short period of time. Cattle, in the presence of other forage, may eat considerable arrow grass with no harm, but when grazing on poor pasture may eat enough in a short time to produce intoxication or death. The sickness comes on very quickly, if at all. Arrow grass loses most of its poisonous property as it dries and probably is not dangerous when cut and cured with hay, says the bulletin.

Ordinarily the poison acts too rapidly for effective use of hydrogen peroxide, potassium permanganate, and cobalt nitrate, which have been suggested as remedies. Atropine may stimulate respiration and may enable the animal to recover. The bulletin suggests the possibility that administration of glucose might be helpful. Glucose combines with hydrocyanic acid and destroys its poisonous properties. Administration might be either by the mouth or hypodermically.

Copies of the bulletin may be obtained free from the Office of Information, Department of Agriculture, Washington, D. C., as long as the free supply lasts.

COLLEGE INCOME

The income to American Colleges and Universities amounts to approximately \$500,000,000 annually exclusive of additions to endowments, according to the United States Office of Education which issued a report covering 1,071 reporting institutions.

Of this total, 25 per cent was contributed in the form of tuition by 919,381 students registered last year; 23 per cent was contributed by state and city governments;

13 per cent through private gifts; 12 per cent came from income from endowments; 10 per cent from room and board charges; approximately four per cent from the Federal Government and the remaining 13 per cent from miscellaneous sources. In addition to the above total an addition of slightly over \$50,000,000 was made to permanent endowment funds through private gifts.—*Trends and Indications.*

GAS IS REPLACING COAL

There is a definite trend throughout the United States toward gas as a fuel to replace coal, according to Dr. Gustav Egloff of the Universal Oil Products Company, Chicago, in a paper prepared for the World Power Conference in Berlin and made public here by the American Chemical Society.

Instead of viewing with alarm the rapid expansion of the gas industry, products of which had a consumer value last year estimated at \$500,000,000, American coal producers should begin the installation of processes for the conversion of coal into gaseous fuel and gasoline of high anti-knock value, thus keeping abreast of the newer fuel developments.

The entire replacement of coal by gas is a worthy goal. The use of gas means domestic convenience, industrial efficiency, and smokeless cities. The present smoke evil, due to the burning of coal in our cities, is a burden that an enlightened civilization should not tolerate.

The soot produced in our cities through the burning of solid fuels is a problem of magnitude. It has been stated that smoke causes an annual loss to the United States of over \$500,000,000. The average cost to each city dweller due to soot from burning coal is estimated at approximately \$15 per year.

The damage done is of many types. Smoke vastly increases expenditure for laundry and dry cleaning. It impairs merchandise, paint, metal work and the surface of buildings. It adds to the labor of housekeeping, and it is an incalculable detriment to the nerve force and health of the nation.

On a purely economic basis, the use of coal in cities cannot be defended. It involves the loading, transportation, unloading, delivering and firing of the fuel, the disposal of ash, the loss of valuable oil constituents that can be reduced by carbonization, and the adding of tremendous amounts to the cleaning bill of cities.

In the use of fuel in the United States a change is occurring that is truly revolutionary. In home and factory alike, tremendous quantities of gas are replacing coal. More than 2,800 billion cubic feet of

gas were consumed in the United States during 1929. Of this quantity, eighty per cent was natural gas, petroleum, still gas and cracking process gas—all products of the petroleum industry.

The 1929 production of natural gas and refinery gas is estimated at 2,320 billion cubic feet. Much of this gas came into direct competition with coal. In fact, the amount consumed as fuel has a heating value equal to ninety-two million tons of coal. The natural and petroleum gas consumed in the United States for fuel purposes was in that year equivalent to one-sixth of its coal production.

By far the most abundant of industrial gases is natural gas. This almost invariably accompanies petroleum underground, and infrequently occurs alone. The gas may be present in the earth apart from the oil strata, or it may be dissolved in the oil under the high pressures which exist in oil fields. These pressures range from a few hundred to above 2,500 pounds per square inch. When oil is produced, gas usually accompanies it in amounts ranging from 200 to 20,000 cubic feet per barrel of oil. Some wells have produced 100 million to 150 million cubic feet of natural gas per day.

Natural gas is carried throughout the United States by a system of widely distributed pipe lines. The total length of these lines is estimated at over 55,000 miles, and their value makes up a large share of the present investment in the natural gas industry of \$1,900,000,000. Since 1925 a number of pipe lines from 100 to over 400 miles in length and three to twenty-two inches in diameter have been constructed to carry natural gas by billions of cubic feet per year. In 1930, for increased distribution facilities for natural gas, an expenditure of \$250,000,000 is expected.

One of the greatest of these pipe-line projects is the twenty-two inch line completed in 1928 from Amarillo, Texas, to Denver and Pueblo, Colorado, a distance of 340 miles. The line required eight months to construct and, with the gas lands secured to assure a lasting gas supply, cost \$25,000,000.

The line rises from 3,800 feet above sea

level at Amarillo to 7,000 feet at Denver. It has a capacity of 100 million cubic feet of gas per day, and needed 81,000 tons of pipe for its building. To supply these Colorado cities, 350,000 acres of gas lands were secured, on which are twenty-eight wells at present producing, with an open flow capacity of 625 million cubic feet per day.

Birmingham, Alabama, and Atlanta, Georgia, are now reached by a 450-mile gas line from Louisiana. A line nearly 400 miles in length, able to handle a peak-load of 250,000,000 cubic feet per day, serves Kansas City, St. Louis, Salt Lake City, Cincinnati, Cleveland, Buffalo, Louisville, New Orleans, Los Angeles. San Francisco and Pittsburgh are other larger cities served by natural gas.

In California, natural gas is rapidly eliminating manufactured gas. More than 5,000 miles of natural gas pipe line have been laid in that state alone in the last ten years; and at present a single company has 700 miles of such lines planned and under construction. When these are completed, ninety-eight per cent of the gas consumption in California will be natural gas.

Over 1,600 miles of gas pipe line radiate from the gas fields of the Texas Panhandle, and plans are now under consideration for a gas line from that region to Chicago, a distance of 1,000 miles.

No definite figures on the potential volume of natural gas in the United States are available. But the building of great gas-distributing systems at a cost of hundreds of millions of dollars clearly indicates that the industry is confident that natural gas is available in staggering quantities and will be a source of power for many years. It is estimated that the two gas fields which now supply San Francisco are capable of producing 4,000,000 cubic feet of gas daily for seventy-five years.

Approximately eighty per cent of the natural gas produced in the United States is put to industrial use. The largest consumers are the producers of oil, who use gas engines for drilling, pumping, and compressing natural gas in gasoline plants. Petroleum refining, generation of electricity, and carbon black manufacture also account for large amounts of gas. The use of natural gas for industrial purposes was

nine per cent greater in 1928 than in 1927.

The superiority of natural gas and also of gas from the cracking process and from crude-oil distillation over other commercial gases for heating purposes is evident from the consideration of the calorific values of the common fuel gases. Natural gas will average approximately 1,000 British thermal units per cubic foot, and crude-oil distillation gas about the same figure, while cracking still gas averages 1,250 B.t.u. By comparison, carburetted water gas has about 500 B.t.u. per cubic foot, coke oven gas is slightly lower, and blue water gas about 300 B.t.u.

In 1928 a total of 320,877,000,000 cubic feet of natural gas was supplied to 4,336,000 domestic consumers in over 2,000 communities in the United States. This was an increase over 1927 of ten per cent in the number of consumers and eight per cent in the amount of gas used. The value of this gas at points of consumption was \$225,000,000.

From an insignificant volume fifteen years ago, the production of cracked gas had risen rapidly, with the development of the cracking process, to an estimated volume of 275,000,000,000 feet for the year 1930.

The modern cracking process has been tried out with success on high- and low-temperature coal tar, creosote oil, cannell-coal tar, water-gas tar and high-boiling tar acids. Gas yields varied from 450 to 700 cubic feet per barrel of charging stock except when cracking tar acids, which gave approximately 1,000 cubic feet of gas per barrel in ordinary operation and 1,900 cubic feet when steam was used.

Another product whose value is not yet fully realized is gas from stills used for the distillation of petroleum at atmospheric pressure. The production in 1929 was approximately 270,000,000,000 cubic feet from nearly a billion barrels of crude oil run to stills. This is an increase of 200 per cent in ten years.

Extension of the use of natural and petroleum gases will partially solve the fuel problem, but the full solution requires the co-operation of the coal industry. The coal resources of the United States can furnish an almost incalculable amount of gas. By carbonization processes, coal can be converted into gas, coke and tar. The

tar can be converted by the cracking process into gas, gasoline and coke. The coke from both carbonization and cracking can itself be converted into water gas or producer gas.

The erection and operation of gas and cracking plants at coal mines would be a tremendous step forward in true conservation. There would be but two products to

ship from these plants: gas and gasoline. The gas would be piped to points of utilization instead of shipping coal. The motor fuel produced at the mine by the cracking process could also be pipe-lined to consuming centers.

The adoption of this plan would be sound fuel progress and a great boon to the nation.

USE OF GAS

The United States has 55,000 miles of pipe lines carrying natural gas to a large part of the industries and homes of the country, and some of these lines extend as far as 400 miles from the producing areas, Dr. Gustav Egolf, of Chicago, told the World Power Conference.

Natural gas is taking the lead in the great change in fuel practice now going on in America which is tremendously increasing the use of all kinds of gas. Two and a quarter trillion cubic feet of gas valued at \$500,000,000 were produced in the old fields of the United States in 1929. Its fuel value is equivalent to that of more than one-sixth of the coal mined in the country during the same period.

Three-quarters of this great output was

natural gas. Petroleum distillation and the cracking process was the source of the remainder and produced a volume equal to that made in all the city gas plants of the country.

The expansion of gas consumption is not seen as a menace to the coal industry, but rather as an enlarged opportunity for it.

Coal will be carbonized at the mines, to furnish gas, oil and coke. The oil should be cracked to gas, gasoline and coke; and the coke should be gasified. The two products, gas and gasoline, would be pipe-lined to consuming centers. This process would be an immeasurable gain to the welfare of the nation as it would mean the burning in the cities of nothing but smokeless fuel.—*Science Service.*

OIL, A BY-PRODUCT OF SALT

The oldest oil field in the world is situated in the west central part of China in the province of Szechuan. It is not operated primarily for oil but for salt, which seems more important to China's millions, to whom time and labor mean little. The gas is used exclusively for evaporating the brine, and the oil is an incidental by-product. An illustrated description of this field by Dr. Arnold Heim of Sunyatsen University, appeared in a recent issue of *Petroleum Zeitschrift*.

Boring for brine, gas, and oil has been

carried out in Szechuan for over 2,000 years. The entire operation, including drilling and pumping, is by hand labor, employing over a million men, who work for 15 to 25 cents a day. The wells vary in depth from a few feet to 3800 feet. Some of the latter have required decades to drill. All the equipment, pipe lines, casing, bit, bailer, and even drilling cable, is made of bamboo. A bamboo plantation is cultivated in the region to supply the material, especially the larger pipe lines which are six inches in diameter.—*Industrial Bulletin, Arthur D. Little, Inc.*

EDISON HONORED BY ARGENTINE

A gold medal typifying the gratitude and affection of electrical engineers and scientists of Argentine for Thomas Alva Edison, and in commemoration of the golden jubilee of his incandescent lamp, was presented to Mr. Edison on June 20 in his East Orange laboratory by William A. Reece of Buenos Aires, president of General Electric, S. A., of Argentine, who acted as the representative of the Argentine Association of Electro-Technicians. C. C. Chesney, vice president of the General Electric Company of this country

no, president of the society, explaining the award. The letter follows:

ARGENTINE ASSOCIATION OF ELECTRO-
TECHNICIANS

Paseo Colon 185

U. T. 2385, Avenida.

Buenos Aires, April 2, 1930.

Mr. Thomas Alva Edison.

MASTER:—

The Argentine Association of Electro-Technicians, founded in Buenos Aires in 1913, has deemed that the 21st day of



EDISON RECEIVES MEDAL FROM ARGENTINE ENGINEERS

and a past-president of the American Institute of Electrical Engineers, presided at the meeting at which the presentation was made.

The medal was executed by Oliva Navarro, a well known Argentine sculptor. It was awarded by the technical society last fall when South America joined with the world in celebrating the 50th birthday of Mr. Edison's lamp. In presenting the medal Mr. Reece handed Mr. Edison a letter signed by N. Besio More-

October, 1879, has been one of the days most worthy of remembrance in our times because of the benefits which have derived therefrom for the welfare of humanity. It has likewise deemed that the work of the noted scientific investigator, who on that day gave us the invention of the electric incandescent lamp, as well as his whole life from his first steps of adolescence to the present moment, has been a masterly model for the youth of Argentina.

On account of these considerations, the

Association decided to celebrate with numerous commemorative events the 21st day of October, 1929. Among these events, which have extended throughout the territory of the Argentine Republic, there was included the presentation to you, dear Master, of a gold medal, as a testimony of the veneration, gratitude, and affection of the Argentine Association of Electro-Technicians and of the "Committee of Homage to Thomas Alva Edison," expressly appointed by the former, as well as of all Argentine electrical engineers, both native and resident, which our institution comprises.

We have asked our distinguished member, on several occasions president of this association—the engineer William Asher Reece—to be good enough to deliver to you personally the gold medal which we dedicated to you and to convey to you verbally our sentiments of admiration and

attachment toward you, whose long existence and fruitful scientific activity we hope will continue for the benefit of the people and the general culture of all the men of the earth.

Engineer Reece, member of our "Committee of Homage," has accepted the honorable mission with which we have entrusted him and he will call at your home to convey to you our devotion and esteem as a very slight compensation for all the benefits which every one of us has personally received from the work of your scientific spirit and your tireless industry, sign of a will invariably consecrated to the service of the highest general interests.

You may rest assured, dear Master, of the friendship and constant admiration of your Argentinean friends in whose name we speak.

(Signed) N. BESIO MORENO,
President.

FLEXIBLE WOOD

Real wood which can be cut with scissors and bent almost double without breaking is offered in a new product which combines the texture and attractiveness of natural wood with the workability of heavy cloth. It is made by cutting a thin veneer, $\frac{1}{60}$ th to $\frac{1}{120}$ th inch in thickness, which is glued to a paper or cloth backing; after being dried it is flexed by a mechanical process. It may be applied to walls by paperhangers and finished with sandpaper, shellac and wax. Although the decorative features and economy of thin veneers have been known and used for many years, it is only recently that they have been made available on a large scale.

The new product can be applied to plaster, metal, wall board, or cheap grades of

wood, which makes it adaptable to a wide variety of uses. One of the most popular is as a wall covering in place of ordinary wood panelling, for which there is a growing vogue. The appearance is said to be duplicated at one-half to one-third the cost, providing a finish which should be readily acceptable in high class homes, hotels, clubs, libraries, stores and executive offices. Since the appearance of wood finishes is generally preferred to that of metal, this new flexible wood may soon be used to cover metal in furniture, office equipment, Pullman car interiors, and elevator cabs, and, although the cost is higher, it may supplant to a large extent the unconvincing use of painted imitations of wood grain.—*Industrial Bulletin*.

MICHELSON

AMERICA'S FOREMOST OPTICAL PHYSICIST

It is my purpose to sketch briefly the scientific achievements of the man whose first researches were carried out at the United States Naval Academy over 50 years ago and who now, at the age of 76, has set for himself three tasks which to others, even in his own field, seem almost Herculean. And furthermore, it will be interesting to note the far-reaching significance and influence on contemporary thought in physics that may be attributed to these major researches of Professor Michelson.

More than three quarters of a century have passed since Albert Abraham Michelson was born in a small village, Strelno, just 40 miles from the birthplace of Copernicus and then, in 1852, a part of Germany, but now within the borders of Poland. But during practically all of that time he has lived in America as a citizen of the United States.

At the age of 16 he was appointed by President Grant as a midshipman at the United States Naval Academy and was graduated four years later in the class of 1873, or as then designated, "Date of '69." One reads with interest Admiral Fiske's account of his boxing tilt with Michelson when they were schoolmates at the Naval Academy, a fight from which Fiske emerged in rather the worse condition. However, upon the admiral's own admission, his admiration of Michelson the "pugilist" is surpassed by his admiration of Michelson the physicist. We also learn from Admiral Fiske that an innate interest in physical experiment and evidence of unusual ingenuity were observed in Michelson during his years as midshipman; although Admiral Worden, so it is alleged, was a bit concerned for the future of one who devoted so much of his time to extra-curricular experiments. Humanity may be thankful for the influence that then permitted the individual to follow his true bent undeviated by the rigid restraints of a military régime.

Not very long after graduating, Michelson was detailed to the Naval Academy (1875-1879) as an instructor in mathe-

matics and physics, and at that time he outlined in a simple, characteristic half page in *Nature* an improved method of determining the velocity of light.

Before the Navy had established a post-graduate school, certain officers were selected and sent abroad for graduate study,



PROF. ALBERT A. MICHELSON

and in this line of duty Michelson spent the years 1880 to 1882 in Berlin, Heidelberg, and Paris; and in the following year he resigned from the Navy to enter upon an academic career. It is interesting to note that 36 years later (1918) he was again on the Navy Register, enrolled in the United States Naval Reserve Force as a specialist. I recall with pleasure making a visit during the War to the roof of his laboratory at the University of Chicago where he was developing an optical range finder for use by Navy vessels.

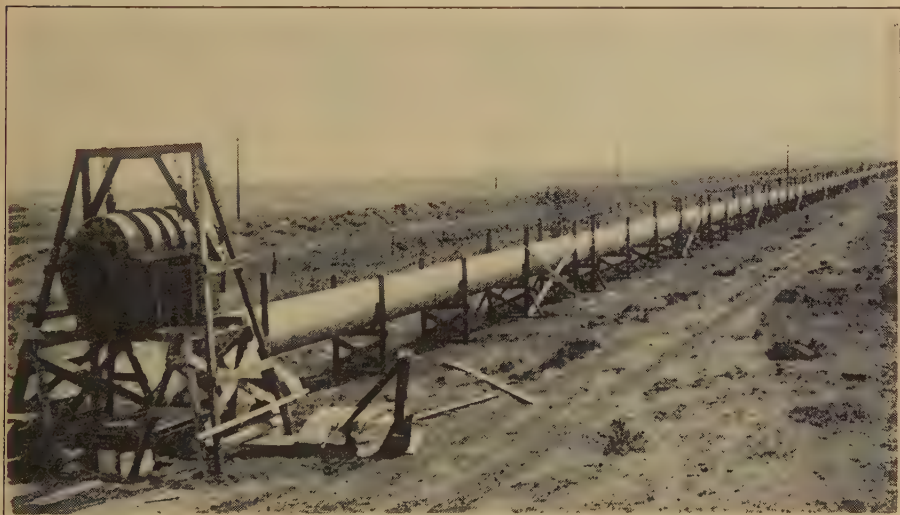
Following his early Navy career, Michelson became a professor of physics first at the Case School of Applied Science at Cleveland and later at Clark University at Worcester and finally, since 1892, at the University of Chicago, to which he was called as head of the Department of Physics.

The recognition of Professor Michelson as a scholar and an investigator of the highest order is borne out by the many honors, both foreign and domestic, of which he has been the recipient. His awards, such as the Rumford Medal, the Copley Medal, and so on, are too numerous to mention here, but one cannot resist pointing particularly to the fact that Professor Michelson was the first American physicist to receive the Nobel Prize Award.

Although for nearly 40 years Professor

bearing and influence on current physical thought.

Probably the first serious effort to find out whether or not the velocity of light is finite was made by Gallileo; but the crudeness of his experiments left him with no evidence that the passage of light from one point to another was not instantaneous. In 1676 the Danish astronomer, Rømer, pointed out that inequalities of the time intervals between eclipses of Jupiter by one of its satellites may be accounted for by the varying distance of the earth from



VACUUM PIPE FOR SPEED OF LIGHT EXPERIMENTS

Michelson has made his home in Chicago, much of his time has been recently spent in California where, even during the past summers, he has been repeating the ether-drift and velocity-of-light experiments, always with new and improved technique, increased precision, and with convincing results. It is thus that we learn of Michelson, at 77, outlining three new tasks which are in brief: the re-determination of the velocity of light; a refinement of the measurement of the diameters of stars; and another search for a possible ether-drift.

It may be of interest to review very briefly the principle researches of Professor Michelson; and then to consider their

that planet due to the periodic motion of the earth about the sun and at the same time assuming a finite velocity of light of about 192,000 miles per second. Subsequently, short-range determinations of this velocity were made, and noteworthy were the toothed-wheel experiments of Fizeau (1849) and Cornu (1874), and at the same time the revolving-mirror experiment of Foucault.

The method of determination of the velocity of light as proposed by Michelson in 1878 was that of the revolving mirror, driven by an air blast and calibrated against a tuning fork of accurately known frequency. The apparatus for this experiment was set up along the sea wall of the

Naval Academy at Annapolis, a position which is now occupied by the tennis courts. Here an unobstructed path of 500 feet between mirrors was obtainable. The results of this experiment were published in the *Proceedings of the American Association for Advancement of Science* in 1878, and the best value obtained, 186,508 miles per second, was a mean of ten independent observations "made under difficulties, and with apparatus adapted from material found in the laboratory of the Naval School."

In the years subsequent to 1878, improvements in the measurements of the two fundamental factors in this experiment, the *distance* interval and the *time* interval of the passage of the light beam, have been made under the direction of Professor Michelson. The distance between mirrors in the 1924 determination was about 22 miles, accurately measured for the purpose by the United States Coast and Geodetic Survey, between Mount Wilson and Mount San Antonio in California. The rotating mirror in this case was in the form of an octagonal prism, each face being an optical flat, and it functioned also as a timer by virtue of its calibration with a standardized tuning fork. This experiment has given what is by all odds the most trustworthy value of the velocity of light, namely, 186,359 miles per second in air.

In the early eighties, when in Germany, Professor Michelson's interests were first directed to the "Aberration Question," which in short was this: "Does the medium, usually called 'ether,' in which light waves are propagated through empty space, remain fixed with respect to the stellar universe while the earth moves freely through it; or does the earth drag the ether with it, as a rapidly moving vehicle carries a quantity of air with it into its motion?"

A study of this question, both experimental and theoretical, has led the way to a vastly greater comprehension of the universe in which we live than has, perhaps, ever been realized before. In particular, the results of the now famous "Michelson and Morley Ether-Drift Experiment," carried out at Cleveland in 1887, gave the initial impetus to the theory of relativity. Let us consider this far-reaching experiment.

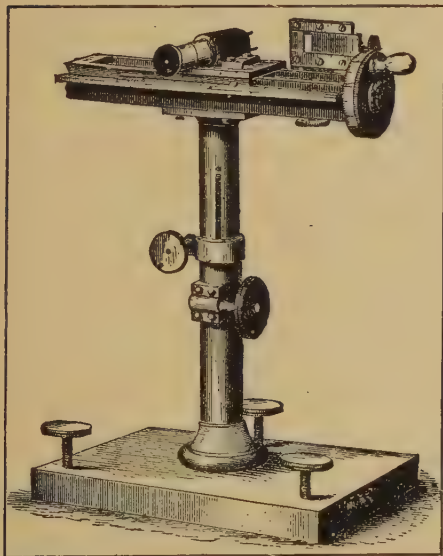
As early as 1880, Professor Michelson conceived the idea of making a direct test for ether-drift by sending simultaneously two beams of light waves out from a point in two mutually perpendicular directions, and by means of mirrors reflecting each back along its own path to the starting point. If during such an experiment there is no drift of the ether, the two beams of light waves will arrive together in step; but, on the other hand, if there is a drift of the ether along the path of one of the light beams, then the two sets of waves will arrive somewhat out of step. To measure such a possible "out-of-stepness" Michelson invented (1882) a simple but tremendously ingenious interferometer, an instrument which has since found application in many and various types of optical measurements.

His first effort to detect ether-drift with an interferometer was in Helmholtz' laboratory in Berlin; but here the vibrations due to city traffic made the use of this instrument impossible, and accordingly the apparatus was moved to Potsdam. The results obtained there, however, were considered inaccurate and therefore of no significance, and were disregarded.

Upon returning to America, Professor Michelson, assisted by Professor Morley, built an interferometer on a large scale at the Case School of Applied Science; and there they made the surprising observation that the light waves reflected back along the two perpendicular paths of the interferometer met one another "in step." The immediate interpretation of this was that there was *no relative motion*, that is, no drift, between the earth and the ether. This experimental observation was repeated later, and with increased precision, by Morley and Miller at Cleveland, and by Michelson at the University of Chicago and in each instance the original Michelson-Morley experiment was substantiated.

This experimental result which indicated no ether-drift was in contradiction to the supposed facts deduced from observations of aberration; and as late as 1900 Lord Kelvin, at the International Congress of Physics held in Paris, averred that the "only cloud in the clear sky of the theory of the ether was the null result of the Michelson-Morley experiment." But at about that time Lorentz, in Holland, and Fitzgerald, in Ireland, proposed an hy-

pothesis to make compatible the results of the Michelson-Morley experiment and the earlier aberration experiments; and it was this hypothesis, now usually referred to as the Lorentz-Fitzgerald contraction hypothesis on which Einstein founded his theory of relativity in 1905. The influences of this theory are too numerous and too profound to mention here, but suffice it to say that they have introduced entirely new and extremely interesting speculations as to the structure of atoms and in general the nature of things.



APPARATUS USED IN 1879

In the years 1921 to 1925 very extensive ether-drift experiments were carried out by Professor Miller at the Mount Wilson Observatory in California. Physicists the world over were astounded when Professor Miller announced an observed motion of the ether of about ten kilometers per second; for such a result was apparently in disagreement with the Michelson-Morley experiment and with the theory of relativity. Professor Miller then carefully repeated the experiment and verified this former result, but the same experiment was done independently at Mount Wilson

by Dr. Roy Kennedy, who found no evidence of an ether-drift. A few years later Professor Michelson went to California and there repeated his ether-drift experiment, and in November of 1928 at Washington he announced to a very eager and attentive audience at a meeting of the Optical Society of America the result of this last and most precise experiment—no observable ether-drift. The contrary results of Professor Miller's experiments, done under his keen supervision and skillful hand, still stand unexplained; but the situation, as recognized by the scientific world, is that relativity remains vindicated.

I wish to refer briefly to some of the other important achievements of Professor Michelson. I have mentioned the interferometer which was devised by him for the purpose of determining a possible ether-drift. This same instrument has found most remarkable applications in other fields of science, notably in the measurement of the distance between components of double stars and in the measurement of the diameter of the giant star Betelgeuse. In this latter instance an interferometer was mounted on the end of the 100-inch reflecting telescope at the Mount Wilson Observatory; the diameter of this great star, located in the constellation of Orion, was calculated to be 240,000,000 miles, a distance about equal to the diameter of the orbit of Mars.

The international standard of length is the distance between two scratches on a particular bar of platinum-iridium kept at Sèvres near Paris, and is known as the standard meter. In order to establish permanently this standard of length so that it might never be lost to mankind due to material destruction, Professor Michelson spent the first year of his appointment at the University of Chicago in Paris in determining this length in terms of the wavelength of a particular red line in the spectrum of cadmium. For this purpose again the interferometer was brought into use and a most accurate determination yielded the result that one meter is equivalent to 1,553,163.5 wavelengths of this particular red cadmium line. And now we may rest assured that even though the standard meter of Paris be destroyed by war, by vandalism, or by natural causes, it could be again reproduced to within an ac-

curacy of at least one part in 3,000,000. It is a remarkable thing and a fortunate one that the wavelengths of the light in the spectrum of any element such as cadmium are identical the world over and probably throughout the entire universe.

From the brief résumé of Professor Michelson's achievements it may be concluded that their distinguishing feature is precision. The economic value of these experiments of precision can not be estimated in numbers but their use in promoting useful and properly directed thought is inestimable, and an interesting discussion of these uses has been given by Professor Millikan in *Science* for May 10, 1929. Certainly of greatest importance, in my mind, is the ether-drift experiment which triggered off the study of relativity, which in turn has promoted thought along the lines of atomic structure, has introduced the notion that energy is intimately related to mass, and has finally led to exceedingly interesting speculations as to the constitu-

tion of stars. Knowledge along this line certainly seems worth while in that, possibly, our future source of energy may be the stars, or, in particular, the sun.

As the Copernican theory led mankind away from geocentric ideas, so has the theory of relativity led him away from egocentric ideas; that is to say, one can no longer honestly estimate velocities and accelerations with respect to himself but must also extend to other stars and even other universes the privilege of being the basis of reference. A most entertaining and illuminating discussion of this subject is to be found in Eddington's recent book, *The Nature of the Physical World*.

These valuable scientific researches in themselves stand as evidence to the skill and mental prowess of Professor A. A. Michelson as an investigator, and the United States Naval Academy may well be proud to count him as one of its graduates, but these researches are apparently not the last.—Prof. William H. Grew.

VACCINE FOR LEPROSY

According to a report from Vienna, Dr. Hermann Dostal, a scientist who had devoted many years of his life to the study of leprosy, has developed a vaccine against that terrible disease, which for many thousand years has been considered incurable. After numerous experiments and tests made by him and a number of other physicians, the conclusion was reached, that, at last, a positive cure for leprosy has been found.

The new remedy, which is known under the name "Lepravaccine Dostal" has already been tried out with highly encouraging success in the leper colony of Bari, in Italy. It is expected to take the place of chaulmoogra oil in the treatment of leprosy or may be used together with it. Dr. Dostal and the physicians who have had an opportunity to try out the new vaccine, are confident, that from now on leprosy is no more serious a disease than tuberculosis. Only in the most advanced cases did the new anti-toxin fail to produce a cure.

The new vaccine was developed by Dr.

Dostal about three years ago, after fifteen years of laboratory work with the lepra bacillus which had been discovered by Dr. Hansen, a Danish scientist. Three years ago, three Serbians, suffering from leprosy came to Austria and from one of them Dr. Dostal obtained a quantity of the Hansen bacilli. He found a method of developing a thriving culture and from it a vaccine, with which he and the specialists of the clinic at Bari made numerous tests with remarkable success. Since then Argentine and Cuba, at the requests of their governments have been supplied with the anti-toxin.

The total number of leprosy cases in the world is estimated or probably underestimated to be about three millions. The largest number of cases is found in China, India, tropical Africa, South America, the Malay States and the East Indies. There are also many lepers in Italy, Poland and Russia and in various sections of the Balkan peninsula.

STEINMETZ'S DREAMS

Dreams do come true—when one as discerning as the late Charles Proteus Steinmetz, General Electric consulting engineer, does the dreaming. Fifteen years ago Steinmetz wrote a magazine article, "You Will Think This Is a Dream," in which he made eleven predictions as to the uses of electricity. Here they are, and with them a concise statement to show how nearly each one has been fulfilled up to the present time.

Prophecy No. 1. "The working day will be reduced to six hours." This has not yet come true, but efficient factory machinery, driven by electric motors, and using instantaneous electric welding, will make this possible—although the five-day or four-day week may be preferable.

No. 2. Steinmetz predicted international radio broadcasting, for he wrote, "Millions will hear concerts in their homes." Over 13,000,000 radio sets were sold in seven years. "Great singers abroad will be heard in our homes." They have been.

No. 3. He predicted talking movies, for he wrote, "The motion picture and the talking machine will be perfectly synchronized." The talkies are being put in our 20,000 theatres rapidly.

No. 4. "Buildings and homes will be heated by electricity, and cooled and ventilated by electricity." Hundreds are heated, thousands are cooled and hundreds of thousands are so ventilated; and nearly 2,000,000 electric refrigerators are in use.

No. 5. "Much of the cooking will be done on the table. Cooking will be regulated by setting a dial to start and stop the electric stove," Steinmetz said. A million stoves operate that way today—set the

dial "start at four" and "stop at six," and supper will be ready at six though the house is empty all afternoon. Tens of millions of other electrical devices are used for cooking on the table. They save steps and time.

No. 6. "Our farms will be electrified," said Steinmetz. Already 600,000 farms have been electrified, and the work is going ahead rapidly now. More farms were connected to power lines in the last three years than in the preceding 43 years.

No. 7. "Electricity will be cheaper," Steinmetz prophesied. Average household rates are now about 25 per cent less than they were 15 years ago.

No. 8. "We will use electricity as freely as water," Steinmetz said. Many of us do now, but do not realize it. We leave fans running and lights burning for hours, but we do not leave the water running long.

No. 9. "Industries in the cities will use electric power and so lessen smoke and dirt," Steinmetz foretold. Much of our present smoke comes from the railroads, and now they are tackling the job of electrification.

No. 10. "Industrial plants will move closer to the source of materials, and the power-houses will move closer to the sources of power." Right again—and when the power plants transmit the electricity, they do not have to pay to transport the coal.

No. 11. "Single power plants will have a capacity of over 1,000,000 horsepower." This prophecy has almost been fulfilled. The largest power plant now is already four times larger than the biggest plant was when Steinmetz made the prophecy.

BYRD'S DISCOVERIES

The American expedition to the Antarctic which is just returning to America with such a record of success is of special interest in the annals of exploration for a variety of reasons. Perhaps the three outstanding features are the large area of new country surveyed, the new light thrown on major scientific problems and, lastly, the new technique in polar exploration, so far as Antarctica is concerned which Byrd and Wilkins have developed.

Byrd's major geographical achievement lies in his charting of the eastern portion of the Great Ross Ice Shelf and the adjacent coast. To this he has added the discovery of a large number of new areas of somewhat less importance, since their major features were known from Amundsen's sledge journeys in 1911-1912, or from Scott's voyage early in 1902. The block diagram will make his achievements clear. Before Byrd's explorations, Scott had traversed the front of the Ross Ice Shelf—sailing far along its icy front, which towered one or two hundred feet above the sea. He reached nearly the longitude 150° west where he was blocked by dense pack ice. He sighted the black rocks in King Edward Land (called Scott's Nunataks) and also the adjacent summits of the Alexandra Range. Amundsen in 1911 and 1912 placed his headquarters at Framheim, which was within a mile or two of "Little America" shown on the diagram. His journey to the Pole was as direct as possible. He reached the Plateau by way of the Heiberg Glacier, and attained the Pole on December 14, 1911. He returned the same way. His surveys were not very complete, and of course were confined to a short distance from his track. He made practically no scientific collections. He reported the presence of Carmen Land, which seemed to limit the low-level Ross Ice Shelf on the east about longitude 150° west.

Let us first of all consider the salient results of Byrd's wonderful flight on November 28 and 29, 1929. Leaving at 3:30 p. m., he rapidly crossed the undulating low icy surfaces of the Ross Ice Shelf and then flew up the Liv Glacier which lies somewhat to the west of

Amundsen's route. By midnight he reached the Ice Plateau at 10,000 feet. He was at the Pole an hour or so later. He came back via the Heiberg Glacier, and then flew east along the foot of the Great Mountain Scarp to obtain a nearer view of the Charles Bob Mountains, which he discovered and named. He found no land where Amundsen placed Carmen Land, and Dr. Gould corroborated this absence later.

His second great flight was for a distance of about 350 miles to the northeast of Little America. This coastline from King Edward Land to the east was previously entirely unknown until Charcot Land (discovered in 1909) is reached some 1,500 miles away. No unknown stretch of the Antarctic shoreline of such extent occurs elsewhere around this huge continent. Byrd's flight last December enabled him to chart 200 miles of new coast, including a great range of mountains separated from King Edward Land by a long fiord or gulf. This new land, lying east of the British Dependency, he calls Marie Byrd Land. The mountains rise to 10,000 feet and the preliminary maps seem to support the view that it is a great scarp or fault-face of the same type as that bounding the Ross Ice Shelf on its western side. About 100 miles from the coast, Byrd discovered the Rockefeller Range between Marie Byrd Land and Little America.

No method of rapid mapping can compare with a photographic survey from the air. At the normal height of flying the camera can photograph a belt of country of the order of 100 miles wide. So that the observer from Byrd's airplane was able to fix with reasonable accuracy the topography in an enormous terrain; where the sledger with his sextant or theodolite would only determine the position of a few of the nearer dominant features.

Quite apart from the discovery of *new* lands, we may therefore reasonably hope for an accurate reconnaissance by Byrd of a belt of country over 1,000 miles long and perhaps 200 miles wide. Such a piece of charting has never been accomplished by any previous Antarctic Expedition.

Let us now consider the scientific prob-



lems which Byrd's expedition has helped to solve. As regards continental structure, the most important result has already been referred to. It seems probable that the low-lying Ross Ice Shelf continues far to

the southeast of the limits assigned to it by Amundsen. It is as if Americans had not yet crossed the States, and were in doubt whether there were a low-level route to San Francisco—or whether a

rugged topography confronted them. The Ross Ice Shelf is probably an enormous sheet of floating ice, reaching to the foot of the giant scarp of the mountain ranges. This scarp (shown in the diagram) towers to 15,000 feet in places, and represents the edge of a block of the earth's crust. This block or "horst" has been thrust up many thousand feet above sea level. It seems likely that Marie Byrd Land is another horst, in which case the gulf covered by the Ross Ice Shelf is probably an area of subsidence of the nature of a "graben." The Charles Bob Range seems to be an extension to the east of the great horst, while the low-lying area seen by Byrd and later by Gould seems to be an extension of the (ice-covered) depression or graben. Thus, there may be a belt of low-lying land or even of frozen sea the whole way between the Ross Sea and the Weddell Sea on the opposite side of the continent. This is a theory advanced by the writer and others, but apparently demolished by the discovery of Amundsen's "Carmen Land" in 1912.

It is not possible yet to discuss adequately the other scientific results of the Expedition. Some of us feared that Byrd would rely entirely on air surveys, but the surface surveys of Dr. Gould and others show that Byrd realizes the limitations as well as the immense advantages of the airplane in the Antarctic. In a journey to the Rockefeller Range—in which Gould's airplane was destroyed in a blizzard—the rocks were found to consist of granites and similar rocks. These are stated to be like those of the Alexandra Range and presumably like those of the basement rocks of the great mountains across the Ross Ice Barrier. It is an interesting fact, which I discuss in my recent book "Antarctic Adventure and Research," that the rocks on the Graham Land side of Antarctica (near South America) belong to one group (the Pacific type) while those of the Ross Sea belong to the other group (the Atlantic type). These two types contain different minerals which are also associated differently. If now the Rockefeller rocks contain feldspaths they will agree with the other rocks of the Ross Sea area. If they are unusually rich

in quartz they will be more akin to the Pacific type. In the latter case we have some evidence for a structural connection between Byrd's region and Graham Land (and also with South America).

In his survey of the rocks at the lower end of the Liv Glacier, Gould has discovered carbonaceous shales which approach coal in composition. Coal has been found at the head of the Beardmore Glacier in 1908 and 1912, but Gould's discovery extends this potential Antarctic coal field possibly 150 miles to the east. It has been suggested that one of the world's largest coal fields occurs either in this great horst, or to the west of it under the Ice Plateau. Its present economic value is doubtful—but scientifically the presence of coal so near the Pole is of the greatest interest. It is not generally known that the present climatic zones of the world did not exist throughout most of the geological record. This record tells us something of the world's history during some 500 million years. Through all that long period the world for the most part enjoyed much more uniform climatic conditions than those which characterize it today. It seems likely that fairly temperate climates extended right to the Poles. So that the presence of valuable coal in Spitsbergen in latitude 78° north is interesting but not unexpected. There is no need to invoke a tropical climate to produce a coal vegetation—though clearly conditions near the Liv Glacier must have been very different some 150 million years ago (when coal vegetation was growing) than they are now. Indeed the most surprising result of the fairly complete geological record from Antarctica is that nowhere do we find any evidence of a Great Ice Age, such as that which today prevents the growth of any living plant higher than a moss. Nor does any living animal larger than an insect a few millimeters long permanently inhabit this great continent of five million square miles. For the discussion of these and numberless other scientific problems in meteorology, magnetism, glaciology, etc., the world awaits with the greatest interest the return of the Byrd Expedition.—*Prof. Griffith Taylor for Science Service.*

FAMOUS CENTENARIANS

Nine persons who had reached the age of 100 or over died in Ohio in 1928, according to an item in a recent issue of the *Journal of the American Medical Association*. Of these nine centenarians, five of whom were women, one was stated to have been 114, according to her original birth certificate. The average age of the nine was said to have been 103 years and six months.

Many individuals are asserted to have lived more than 100 years, but most of the reputed centenarians are found on rigid investigations not to be centenarians at all. The age of a very old person seems to be one of the matters most susceptible to deviation from the truth, for memories are usually hazy in the extremely old, and the relatives, friends, and neighbors of these patriarchs seem always ready to exaggerate their antiquity. A few years ago a Kentuckian named John Shell received considerable notoriety as being 131 years of age, but a somewhat searching inquiry revealed him to be not more than 100, if he were even that.

In 1904 a Russian newspaper calmly reported the death at the advanced age of 180 of a woman named Threse Abalva. Another Russian newspaper in 1926 was more modest, for it allotted only 138 years to Ivan Tretya, a peasant of Rostov. A Hungarian farmer, Peter Zortay or Torton, exceeded them all for he was supposed to have been 185 when he died in 1724; as was also St. Mongah, whose death occurred in 1781. Some months ago Henri Barbusse, the French author, recounted his visit in Georgia in Transcaucasia to Nikolai Andreyevitch Shapkovsky, who was reputed to be between 142 and 147.

The cautious reader will regard these allegations with as much skepticism as interest.

One of the most famous of the very aged persons of history was Old Parr, who was said to have been born in England in 1483 and to have died there in 1635. He was working blissfully as a farm laborer at the tender age of 152 when an interested nobleman, the Earl of Arundel, whisked him off to London and put him

on exhibition. The fast life of the metropolis proved too much for him and he promptly succumbed. Thereupon, one John Taylor, known as the "Water Poet," got out a book called "The Olde, Olde, Very Olde Man," in which he extolled this long life in prose and verse, or what passed for verse. Thomas Parr was said to have married at 120, and after the suitable interval to have become the father of a child. When he died in 1635, the celebrated William Harvey, discoverer of the circulation of the blood, performed an autopsy on him and found his general condition good, though the brain cells were somewhat worn. A reprint of Taylor's book was issued by James Caulfield of London in 1794.

Old Parr's unusual age was accepted until 1873 when Mr. W. J. Thoms, deputy librarian of the House of Lords, who was so unkind as to make a real investigation of the case, concluded that about 50 years had been improperly tacked on to the actual life of Parr. The gentleman was a real centenarian, but little more than that.

Mr. Thoms also exposed two other notorious long-lifers. A certain Countess of Desmond was credited with 140 years, but the doubting librarian showed that the ages of two separate countesses of the same name had been added together; instead of one person living to 140 years, two ladies had each lived about 70. Thoms examined, in all, 22 cases of alleged longevity and found that none of the records sustained the contentions of centenarianism.

A writer familiar with Mr. Thom's iconoclasm on this subject, a Mr. John B. Bailey, wrote a book in 1888 which he called "Modern Methuselahs," and in it he cited a number of instances of well-known centenarians and nonogenarians.

He began with St. Anthony, who was said to have lived to 105, but most of his other examples, such as the Emperor Cantacuzenus of the 14th Century, Pletho, Cornaro, Titian, de Fontenelle, and Amory, were only 99 or 100. The author, however, did list a dozen cases which he believed to have been actually 100 years old or more. This writer waxed philo-

sophical in his final chapter and, while admitting that these human century plants reached their great ages in spite of a diverse variety of habits, offered a recipe for longevity. His three essentials for "long-lasting" were: good heredity, good digestion, and bodily and mental activity. He quoted these words of Sir Benjamin Brodie, "Men have been known to die, literally speaking, of disease induced by intellectual vacuity."

One of the best surveys of centenarians was made in 1899 by T. R. Young, former president of the British Institute of Actuaries. At that time he could find only 22 indisputable instances of such aged persons, but in a second edition published in 1905, he added eight more. The longest authentic life he could discover was one of nearly 111 years. Mr. Young discusses all of the previous works on longevity, of which there had been a considerable number, such as the works of Flourens in 1855, of Pinney in 1856, and of Humphry in 1889, as well as that of Bailey alluded to above. Contrast the conservatism of Young with the exuberance of one James Easton, who in 1799 got out a book listing 1712 persons who had lived 100 years or more between 66 A. D. and 1799 A. D. Old Parr and the Countess of Desmond were both on his list.

In a rather weighty tome on the prolongation of life, Professor Eli Metchnikoff, the famous bacteriologist, hazarded the opinion some 20 years ago that human life ought to average at least 120 years. In his book he describes various persons who were supposed to have attained great ages. Among them were Marie Priou, who died in 1838 at the alleged age of 158, after subsisting for most of her life on cheese and goat's milk; and there was also Nicole Marco, who lived to be 110 on a diet of bread and milk.

The Metchnikoff formula for long life was to drink soured milk containing the Bulgarian bacillus, though he also recognized the value of hygiene and sanitation. Today it is known that it is not the *B. Bulgaricus*, but the *acidophilus bacillus*, in soured milk which exerts a favorable influence on the digestive tract and hence contributes to longevity. Metchnikoff's theories were based on observations on the vigor and longevity of various Balkan peoples who lived on such fare. It is

claimed that Bulgaria has more than 3000 centenarians even today, while other Balkan countries such as Rumania and Turkey are likewise so favored.

A woman, Maria Ustav, who died in Carcalia in Rumania in 1927, was asserted to have been 135, while Milo Frantsitch of Yugoslavia, who also died in 1927, was reputed to be 126. Zaro Ago of Constantinople was living there in 1928 at the alleged age of 145. These people are undeniably old; you can believe the actual ages given for them or not, as you think best. Personally, I have my doubts.

The alacrity with which newspaper writers seize upon convenient facts regarding supposed centenarians and exploit them in the press is well illustrated by the news story about old Nah-Nee-Num-Skuk, which appeared in the papers a year or so ago. This ancient red man was definitely asserted to have been born in 1809 and thus to have been 118 years old in 1928, but not one scintilla of real evidence of his age was offered, unless the fact that he had had six wives could be so considered. More than a mere statement of extreme old age is needed to be convincing. There is, unfortunately, no way to diagnose exact age from appearances or physical condition. Authentic birth records offer about the only reliable proof.

In the Massachusetts town of Shutesbury is a monument to one Ephraim Pratt, who is stated to have died there in 1804 in his 117th year. According to the inscription, "He swung a scythe 101 consecutive years and mounted a horse without assistance at the age of 110." An investigation of this case by Mr. Leon F. Whitney revealed that old Ephraim had indeed been a centenarian, but that he did not live more than 100 years. Mr. Pratt's longevity was attributed to his diet, which was said to have consisted chiefly of bread and milk.

The question arises as to whether diet may not actually have an effect on the length of human life. That it may do so is indicated rather definitely by some extensive experiments conducted in the laboratory of Professor Henry C. Sherman at Columbia University in New York. For more than ten years extensive nutritional investigations have been carried out there on white rats. In a study of 400 of these animals, it was found that by doubling the

amount of powdered milk in the diet, a gain of exactly 10 percent resulted in the span of life for both the males and females.

In human experience (for studies on laboratory animals may properly be compared to it) this would indicate that at least six years could be added to human life by means of proper and optimal nutrition. Pure milk, the most nearly perfect of the foods of man, was successful in lengthening life in this instance, and it is interesting to note that most of the famous true centenarians are reported to have subsisted largely on diets in which dairy products have been prominent.

Nutrition is, of course, only one of many factors which may influence longevity. The most important element in the ability to live long unquestionably is heredity. If all or most of our immediate ancestors attained to ripe old ages, generally well past the proverbial three score years and ten, it is likely that we shall also do so, provided we can escape the ravages of disease, avoid accidental death, and refrain from being hung for our sins.

Given two persons who, like Professor Sherman's rats, had exactly the same heredity and the same environmental conditions throughout life, the one who partook of an optimum diet during his entire existence would probably live longer than the one who had only an adequate diet. Such severe conditions are, however, practically never encountered, though there are instances of identical twins who have been separated in infancy and brought up under different environmental conditions, with the result that one has displayed an adult physique superior to that of his twin brother.

Most of the recipes for longevity are no more scientific than that given in a book printed in 1722 which revealed the secret of "rejuvenescency" of one Arnoldus de Villa. It consisted mainly of eating stewed vipers. Similarly, many of the warnings against practices which are stated to be sure to shorten life have little if any scientific foundation. Some of the current food faddists, for example, are vigorous in condemning white bread and

attributing all of the ills of mankind to its use. The scientist realizes, however, that a diet with bread and milk as the basis comes as near to fulfilling average physiological needs as can any combination of known foods.

The real centenarians are reported to have subsisted on all kinds of fare and have indulged in all sorts of hygienic practices. Some of them have eaten white bread, and some brown; some have smoked continuously and violently, and some never; some have partaken of the cup that cheers, and some have been total abstainers; some have trodden the primrose path, and some have been celibates; some have been cheerful, and some morose. Every centenarian usually attributes his longevity to his own peculiar mode of life, regardless of its correlation or lack of it with the accepted rules of hygiene.

The fact that some centenarians have reached great ages without special regard to hygiene is not, of course, an argument in favor of such a regimen. Luck may have been with them, and fate may have played its mysterious part. The average span of life has increased greatly in the last half century, though practically all of the increment has been in the ages below 50, particularly in the periods of early life. This increase has been due to many conditions, of which improved sanitation, better nutrition, more favorable economic circumstances, and biological influences are among the leading factors.

Although a regimen of life might be outlined for an individual case which ought theoretically to assist in prolonging that particular life, positive assurance could not be given of its success, because there are so many complicating factors. There is, in fact, no definite recipe for longevity, and the fountain of youth is still unknown, though science is nearer to the explanation than it ever has been and it may conceivably uncover the secret sooner or later. The average duration of life will unquestionably continue to increase and the mortality rate to decrease, until the biological limit has been reached. When that will be, no conservative scientist can foretell.—*James A. Tobey.*

INDUSTRIAL REVOLUTIONISTS

Industrial revolutionists, those scientists and technologists whose genius and ideas have changed the course of our modern industrial era, are the individuals who remake and rule our civilization, Watson Davis, managing editor of Science Service, declared in a radio talk given under the auspices of Science Service.

We have among us today a few men whose ideas and genius, mixed often with a dash of luck, have influenced our civilization profoundly, Mr. Davis said. Often their names are virtually unknown to the public and the man in the street benefits from their labors without knowing whom to thank if he should feel so inclined.

With apologies to Mr. James W. Gerard who recently picked a list of "rulers of America" which was conspicuous for its lack of government officials, let me assert that while the chairmen of boards of great corporations may rule our financial and even our political destinies, they do not mold our civilization.

It is not easy to pick the industrial revolutionists living among us today, but there are some who have seen their genius and hard work have a major effect on industry.

I nominate as today's industrial revolutionists:

Thomas A. Edison, who invented the incandescent electric light, who would be perpetually famous if that were his sole gift to mankind, but who pioneered in motion pictures and a multitude of other fields.

Orville Wright, joint inventor of the airplane, who was the first to fly in a heavier-than-air aircraft, an achievement that made possible the development of the air transportation of today.

Mme. Marie Curie, because with her husband she isolated radium, the radioactive element which has found commercial use as well as utilization in the treatment of cancer and other diseases.

Guglielmo Marconi, inventor of wireless telegraphy.

Dr. Lee De Forest, whose invention of the three-element electron tube laid the foundation of the great radio industry of today and who has been a pioneer in the development of talking motion pictures.

George Eastman, because he invented photographic film which made amateur photography easy and motion pictures possible.

Dr. Elihu Thomson, electrical engineer, whose researches on alternating current laid the foundation for the extensive transmission and use of electricity today and who is the father of electric welding, the silent builder of steel skyscrapers.

Dr. Fritz Haber and Carl Bosch, who, working for the great I. G. chemical combine of Germany, developed the production of synthetic nitrogen from the air by the direct synthetic ammonia process on such a scale and so economically that agriculture and industry are made independent of the natural nitrates of Chile.

Dr. Leo H. Baekeland, chemist, who invented bakelite, the synthetic plastic made from formaldehyde and carbolic acid, and who invented velox, photographic paper.

Georges Claude, French inventor and engineer, who devised the method of liquefying oxygen and other gases, invented the neon electric lamp and is now working on a method of obtaining power from the temperature differences in seawater.

Frederick E. Ives, inventor of the halftone process of illustration reproduction that is used thousands of times every day throughout the world in the printing of magazines, newspapers and books.

The group of Bell Telephone Research Laboratories engineers, headed by Dr. Herbert E. Ives, son of the halftone inventor, who brought talking motion pictures by two processes to such commercial perfection that the motion picture industry went sound nearly overnight, who also perfected a process in television over wire and radio, and who has constantly improved the telephone.

Dr. W. D. Coolidge, General Electric physicist, who invented the X-ray tube in common use which bears his name, and who invented the tungsten filament electric light.

Dr. Frederick Bergius, German chemist, who invented the hydrogenation of coal process with which oil can be made from coal and which is now being used in the

refining of petroleum, and who is now developing a process for making edible carbohydrates from waste wood and other cellulose products.

Dr. Michael I. Pupin, who rose from immigrant to inventor, because of his invention of loading coils for telephone lines which makes possible conversations across continents.

Dr. F. G. Cottrell, who invented the electrical precipitation of fine dust and other particles which is used to such advantage by smelters, cement plants and other industries that otherwise would pour out wastes that would pollute the air that we breathe.

Dr. William M. Burton, whose process of cracking petroleum has made possible the production of enough gasoline to run the automobiles of the world.

Sir Charles Parsons, the British engineer who invented the steam turbine.

Sir Robert A. Hadfield, English metallurgist, who pioneered in the production of manganese and silicon alloy steels.

H. Brearley and Dr. W. H. Hatfield, English metallurgists, who pioneered in the production of stainless or rustless steels which now have wide commercial use.

Dr. Irving Langmuir, General Electric chemist, who invented the gas-filled electric lamp and atomic hydrogen welding.

The group of American chemists, including Prof. H. P. Cady of the University of Kansas, Dr. R. B. Moore and Dr. F. G. Cottrell, then of the U. S. Bureau of Mines, and their associates, who during the World War extracted from natural gas the sun-element, helium, hitherto known only as a rare inert elemental gas, and supplied it in such quantities that it now floats large airships.

C. Francis Jenkins, inventor, who pioneered in motion pictures and radio-vision.

Chemists of the du Pont companies, who developed a new kind of paint, pyroxylin lacquer, and made it possible to paint automobiles with a cellulose compound.

Chemists of the I. G. Farbenindustrie A. G., Germany's dye trust, who produced new dyes, drugs, and other synthetic organic chemicals.

Dr. Robert M. Yerkes and his psychological associates who during the war devised the army mental tests which demon-

strated to industry the utility of such tests.

Clifford W. Beers, "the mind that found itself," who, because of his experiences in an insane asylum, founded the mental hygiene movement which is rescuing thousands from mental illness.

Dr. S. M. Backcock, University of Wisconsin chemist, whose tests for butterfat content of milk put the dairy industry on a firm scientific basis.

Dr. L. O. Howard, veteran government entomologist, who long led America's war on the insect and who aroused the nation to the necessity of fighting insect invaders which menace health, crops and livestock.

Prof. George H. Shull, botanist, who showed how to breed corn of higher yield that has meant millions of dollars to American farmers.

Dr. John Mohler, chief of the U. S. Department of Agriculture's bureau of animal industry, whose vigorous fight against foot-and-mouth disease of cattle has subdued that scourge and saved the livestock industry untold loss.

Dr. Marion Dorset, Department of Agriculture biochemist, who developed methods of immunizing pigs against cholera and thus saved heavy losses in the industry of hog raising.

Dr. Theobald Smith, dean of American bacteriologists, whose work on Texas fever removed the menace of that disease to cattle, but more important, proved that insects can carry disease.

Dr. Casimir Funk, who invented the term vitamin and called the attention of students of nutrition to early work on beri-beri. This ushered in intensive research upon vitamins with resulting changes in food habits.

To this list there should also be added many pioneers in medicine whose researches have conquered many diseases.

And there cannot be included in this list the names of thousands of individuals who have aided in the birth of new ideas or perfected them so that they could do industry's work.

Great and important names in science, such as Einstein, Michelson, Millikan, Morgan, Rutherford, and a host of others are not in this list because their work, for the most part, has not yet been translated into industrial effects."

ANCIENT FINGERPRINTING

The fingerprint system of identification, which plays such an important part in detective work, is one of the many things generally considered to be thoroughly modern which actually had its origin in practices common in the Orient several hundred years before the Christian era, according to Dr. Berthold Laufer, curator of anthropology at Field Museum of Natural History.

On exhibition at Field Museum are a number of ancient clay seals from China, intentionally marked with thumb or finger prints used for purposes of authenticating documents on which the seals were imprinted. Also, illustrating an altogether different phase of the use of fingerprints, are several paintings executed entirely by employing the artist's fingertips and nails for spreading the ink or paint, instead of a brush.

While the use of fingerprints in India preceded adoption of the system by the western nations, and the idea seems to have reached Europe from there, evidence is available to support a hypothesis that it originated in ancient China and reached India through Chinese emigrants or due to commercial intercourse.

Finger and thumb prints, and even im-

prints of the whole hand, were widely used as signatures on legal papers in ancient China. They were not used, however, for identifying criminals.

Crime never assumed vast proportions in China. When crimes were committed, detection and capture were usually comparatively easy, and nothing like a criminological science was required for the patriarchal organization of government in the old China.

Some of the finger paintings executed by the Chinese reach a high artistic level.

The origin of finger painting seems to be somewhat linked with the practice of finger prints, and may have received its impetus from the latter. Chinese words for both are closely related. It seems, also, that in finger painting the idea of magic was prevalent, and that the artist by immediate bodily touch with the paper or silk was enabled to instil part of his soul into the work. There is reason to suppose that further research might indicate that finger painting is a most ancient and primitive method of drawing and painting, practiced long before the invention in the third century B. C. of the writing brush of animal hair and the older wooden stylus.

A NEW BREAD

Have you tasted the new bread—YUCA bread? Thousands of Cubans are giving this bread a trial, samples having been widely distributed by the Cuban Department of Agriculture. Furthermore, a number of Cuban bakeries are using about 20% of YUCA flour in the manufacture of bread.

Yuca, as such, is little known in the United States, but tapioca, one of its derivatives, is extensively consumed in the American home. In tropical countries the food derived from this plant is consumed by millions of people. All over the American tropics the visitor sees natives eating Yuca but he hesitates to partake of it himself. Yet he is told that it is good and nourishing; perchance he tastes it—nothing more.

In Cuba a yuca flour company has been formed and operations have started at Jaruco. The machinery, while grinding a

limited quantity of yuca, is capable of a larger output if the new flour meets a popular demand. This industry man mean that Cuba will eventually purchase smaller quantities of wheat flour abroad.

Today in the search for additional foods the scientist is finding that the hot zones have many food products that have never been brought to the United States in quantity. The experiments now being conducted by American agricultural specialists in a jungle in Honduras promise a variety of foods that northern people have never enjoyed.

The yuca plant grows 8 or 10 feet in height in a year; one plant may produce 25 or more pounds of roots from which tapioca and other articles of food are derived. In the forests of the Amazon the yuca root is the staff of life. Natives bake the roots in ashes and the cooked product somewhat resembles baked potatoes.

PATENTS ISSUED IN 1929

Inventors throughout the country stimulated by the wave of prosperity which was still showing great vigor in the first part of the last fiscal year, established a record for all time in their dealings with the Patent Office during the twelve months which ended June 30. While the industrial decline was clearly apparent during the greater part of that period, Patent Office figures made public this week showed that the creative effort previously encouraged on such a large scale had continued in numerous cases to fruition.

Thomas E. Robertson, Commissioner of Patents, observed that many of the patents represented developments in the mechanical and chemical fields, which have come to be the fairways of modern life.

AUTOS AND SILK INDUSTRIES LEAD

Applications, he remarked, were particularly noticeable in the automotive and artificial silk industries, although it was not possible at this time to pick out individual cases which could be classified as outstanding. Inventions, he explained, must prove themselves, and that seldom transpires within the year they are patented.

During the last fiscal year his preliminary statement showed the applications for mechanical patents totaled 91,430 as compared with 87,039 in the preceding year. Applications of all kinds, including trade marks, reached a total of 117,789, of which 68,801 resulted in the actual issuance of patent papers, including 19,202 trade marks.

The 49,599 patents issued exceeded the total of the preceding fiscal year by 5,982. In addition 57,566 assignments and licenses were filed as compared with 52,544 in the fiscal year 1929, with assignment fees collected by the Bureau rising from \$98,896 to \$111,805, reflecting in a measure the increased willingness to highly competitive industry to accept new ideas.

The figures brought the total of patents issued in the last ten fiscal years to 424,574. This, it was pointed out, proved that decade as more productive, in the numbers of inventions at least, than the entire first century of the history of this nation.

OFFICIAL REPORT

The official statement issued early last week read as follows:

"The number of applications for mechanical patents exceeded by more than 4,000 the number filed during the previous year, increasing from 87,039 to 91,430. (The total number of applications of all kinds, including trade marks, etc., was 117,789.)

"The number of patents issued amounted to almost 50,000, the exact number being 49,599, or 5,982 more than the previous year. (The total number of issues, including trade marks, etc., was 68,801.)

The number of assignments and licenses filed for record increased from 52,544 to 57,566, or more than 5,000, the assignment fees increasing from \$98,896 to \$111,805, or 13 per cent.

"The Patent Office '10 cent store' also did a phenomenal business, since the number of printed copies disposed of during the year increased from 6,405,000 to 7,453,000, or 17 per cent. In fact the number of printed copies disposed of increased from 5,595,000 two years ago is 7,153,000 last year. This means that each day the Patent Office disposed of 5,000 copies more than it did two years ago.

"The number of photostats made by the Patent Office increased during the year from 713,000 to 978,000, or 37 per cent, bringing in a profit of over \$40,000.

"The total receipts for the year were over \$4,000,000, or \$300,000 greater than the previous 'peak' year, 1928."—*Herald-Tribune*.

PATENTS FOR PLANTS

The inventor or discoverer of a new variety of fruit tree or plant would receive the same protection by a patent as the inventor of a machine, through an amendment to the patent statutes introduced by Senator Townsend of Delaware, himself an orchardist, who said that he wished to remove the present "discrimination" against agriculture.

The patent would be granted to the experimenter under almost identical conditions governing other inventions and the law would be operative throughout the Patent Office, costing the government nothing, Senator Townsend explained, inasmuch as the Patent Office is self-supporting.

His measure, which has been passed by the Senate and approved by the House Patents Committee, reads, in part:

"Any person who has invented or discovered . . . any new and distinct variety of a sexually reproduced plant other than a tuber-propagated plant or a plant which reproduces itself without human aid, not

known or used by others in this country before his invention or discovery thereof, and not patented or described in any printed publication in this or any foreign country, before this invention or discovery thereof, or more than two years prior to his application, and not in public use or sale in this country for more than two years prior to his application, unless the same is proved to have been abandoned, may, upon payment of the fees required by law and other due proceedings, obtain a patent therefor."

In evidence of the value of his proposal, Senator Townsend, who owns 130,000 acres of orchards, pointed to the accomplishments of engineers during a century of patent protection.

Pointing out that "it is a notorious fact that the most successful plant breeders have lived and died in comparative poverty," Senator Townsend named as examples Ephraim Bull, Luther Burbank, Peter Gideon, C. G. Patten, J. R. Rea-soner and Dr. Van Fleet.

MUSK-OXEN TRANSPLANTED TO ALASKA

In an effort to replace the lost musk-ox herds of northern Alaska, the U. S. Department of Agriculture has arranged to import thirty of these odd but valuable animals from Greenland. They will make a long detour on their way, for they are to be brought first to New York, thence by rail to Seattle, and finally by steamer and rail again to Fairbanks, Alaska. Representatives of the Bureau of Biological Survey, skilled in the handling of wild animals in transit, will accompany them all the way.

The little herd will be an expensive one, for an appropriation of \$40,000 has been set aside to cover the cost of its acquisition, transportation and establishment in the protected enclosure that will be its new home. But it is expected that

the animals may eventually pay for themselves many times over, as the imported reindeer have done, by becoming the basis of a new meat-producing industry utilizing food plants that now go to waste. Alaska once had a fair number of musk-oxen in the northern part of the territory, but indiscriminate hunting by explorers, traders and natives with newly-acquired firearms exterminated the herds.

The musk-ox is not an ox, in spite of its name. It looks a little like a long-haired but diminutive brand of cattle, but zoologically stands in a "missing-link" position between cattle and sheep. Its Latin name, *Ovibos*, is a recognition of that fact, for it translates literally into "sheep-cow."—*Science Service*.

PRESENT CHARACTERS USED IN MUSIC

The present characters used in music are a growth; and it is an interesting study to watch this growth from the earliest effort at representing musical thought, down to the present system of notation, which is remarkable for possessing many of the properties of an universal language.

In all civilized countries musical symbols are the same, and musical compositions, when carefully written, receive everywhere substantially the same interpretation. In ancient times, to record musical ideas was a matter of great perplexity even among those who could express other forms of thought in refined and appropriate language. The earliest attempts at expressing musical sounds on paper were made by Alypius, a Greek, about 400 A. D.; the signs adopted seem to have been the letters on the Alphabet, which, to convey from one mind to another the pitch and duration of the sounds, were placed erect, or inverted, mutilated, or commingled, or cast into fanciful forms, so that by degrees there were 100 such characters in use. This complicated system yielded in Medieval times, to a system of Numes, which consisted of dots, points, accents, and other such hieroglyphs placed over the words to be sung, without lines or indication of clefs, each mark having a separate value. This system lasted from the 8th to the 12th century. There was quite an improvement in musical notation when, about the tenth century, a single line was drawn over the words and the position of the numes or notes, over and under this line, defined their meaning more distinctly. A second line was afterwards added, one line being made red and having the letter F at the beginning of it, the other yellow, with the letter C, and from these apparently grew up the clefs C, F, G, of our modern notation. Musical symbols gradually became simplified by an increase of lines, and numes changed into what are now called notes. But as late as the 13th and 14th centuries, numberless

crooked marks, loops, curves, hooks and wavy lines were used. The earliest use of the four-line staff is to be found in England. The ancient notes belonging to the four-line stave were called large, long breve and semi-breve. The long and breve is still used in Church music. The introduction of the present notes called semi-breve, minim, crotchet, quaver, semi-quaver, etc., is ascribed to Jean de Muris, a doctor of the Sorbonne, who made these important additions to musical notation in 1338.

But the man who is honored by historians as "the father of music," as we know it, is Guido Aretinus, a Benedictine monk of the eleventh century. He is credited, at least, with having given an impulse to the study of music such as it had never received at the hands of any one man. Among his other inventions are the names given to the seven notes of the scale used in singing; they were taken from the initial syllables of the lines of a hymn to St. John the Baptist, which was a favorite in Guido's day; running thus:

Ut queant laxis,
Resonare fibris,
Mire gestorum
Famuli tuorum;
Solve polluti
Labbii reatum,
Sancte Johannes.

In later times the Sa was changed into Si and thence into Ti, and Ut into Do, excepting in France. In Arezzo, Italy, where Guido is supposed to have been born, a statue of him was dedicated, on the 2nd of September, 1880, the date being pronounced, by some recent authorities, the nine hundredth anniversary of his birthday. Also, a portrait of him hangs on the wall of the refectory in the Monastery of Avellana, bearing the inscription, "Beatus Guido, inventor musicae." The earliest note printing from movable types was by Ottavino du Petruccio, in 1466 but the neat printing of modern music belongs to the last century.

ADVICE TO STUDENTS OF AVIATION

All persons desiring to become licensed pilots should bear in mind that while they may pass the physical requirements for student and private pilot licenses, that is no guarantee they will not have difficulty with the physical examinations for limited commercial or transport licenses.

Many former students have been physically disqualified when they applied for limited commercial or transport licenses, and, as a result, considerable misunderstanding and disappointment have arisen. Therefore, the medical section of the Aeronautics Branch desires at this time to disseminate as much information on the subject as possible.

The medical section approves or disapproves a medical examination upon the basis of the grade of license applied for. If a student examination shows that the applicant just barely meets the physical requirements for that grade, he will be qualified for it. However, the medical section can not write the applicant that while he has been approved as a student pilot, and will be approved later for the grade of private pilot, his examination is unsatisfactory for either limited commercial or transport pilot and therefore he will not be able to reach either of these grades of licenses as long as his present defects exist.

The reason the medical section can not do this is because it has no way of knowing, out of the total number of student applications received, what students plan to become limited commercial or transport pilots.

There are two fundamental principles that a student should keep in mind when he starts in training.

1. If his sole desire is to become a private pilot for the purpose of flying his own plane when and where he pleases, and if he has no desire to operate commercially, he should take the student physical examination. If satisfactory, this examination will also qualify him for the grade of private pilot when he becomes eligible for the flight test and the written examination for that grade.

2. If a student's sole purpose in applying for a student permit is to become later

a limited commercial or transport pilot, he should take the transport physical examination at the start. In this way he will know before he starts his training whether he has any defects which will bar him from qualifying for that grade of license he ultimately desires.

The student who desires to become a limited commercial or transport pilot will not be put to any more expense for medical examinations by following this advice, because, although he pays \$15 for the transport examination, this examination includes tests that will not have to be made again no matter how long the interval may be between the date of the examination and the time at which he becomes eligible for the limited commercial or transport license. If he takes the student examination for \$10, he will later pay \$5 for that portion of the examination not made originally.

The attention of student applicants also is directed to the following:

1. The Department of Commerce maintains two types of physical examination, one for student and private pilot and one for limited commercial and transport pilot. The requirements for student and private pilot are, of course, very much more lenient than those for limited commercial or transport pilot.

2. Any applicant who has been physically qualified for student pilot on the basis of a satisfactory student examination will be physically acceptable for private pilot at a later date, provided, of course, that his physical condition has not changed adversely in the meantime.

3. Any applicant who has been physically qualified for student pilot on the basis of his having taken and passed a transport physical examination, will be physically acceptable for any grade of license applied for at a later date, again provided that his physical condition has not fallen below standard in the meantime.

4. When a student applicant takes the transport physical examination and finds that while he qualifies for student and private pilot, he does not qualify for limited commercial and transport pilot, he

should write the Medical Section, Aeronautics Branch, Department of Commerce, Washington, for an official opinion on his defects. The Medical Section will inform him what the possibilities are of his receiving medical approval for the higher grades of license by a waiver.

5. If any applicant is physically disqualified for student pilot, he is at liberty to inquire of the Department the nature of his defects, and if the medical section believes there is anything in the way of treatment that will reasonably improve the defect, the applicant will be so advised.

6. When a student applicant has been physically disqualified by a medical examiner, he should await action on his examination by the Department. He should not visit other examiners in an effort to qualify, for even if an examination made by another medical examiner is satisfactory, it will not be accepted. Under such circumstances the Medical Section will require that the applicant return to the original medical examiner in order to demonstrate to that examiner that the disqualifying features are no longer present.

7. Prospective applicants who know they have certain physical defects are invited to communicate with the Medical Section and state the nature of the defects. The Medical Section will inform the prospective applicant whether or not the defects are disqualifying.

8. The student permit of any student will be suspended in case of an accident in which he sustains personal injuries such as to interfere materially with bodily

functions. The suspension of the student permit will be maintained until the student is able to submit to a physical examination, made by an authorized medical examiner, showing that the student has recovered from his injury. In case of partial recovery, the medical section will determine whether or not the recovery is sufficient to warrant removal of the suspension.

9. In order to make the visual requirements clear, special attention is directed to this paragraph. The lowest vision acceptable for student pilot is 20/50 in either or both eyes, without correcting lenses. Judgment of distance must be within the normal specified limits, without correcting lenses. If the student just meets the foregoing minimum requirements, he is required to wear correcting lenses in his goggles, bringing his vision approximately to normal. His judgment of distance must be within qualifying limits while wearing this correction. Failure to meet any of the foregoing requirements will result in disqualification.

10. When it is necessary for the student to wear corrective lenses in his goggles, the correction should be ground into the goggle lenses. Small corrective lenses fastened on the inside of the ordinary goggle should not be purchased. Students should be very particular in these matters, for incorrect lenses often result in harm to the vision.

11. Student applicants who do not meet at least the minimum physical requirements will not be recommended for license. Waivers will not be recommended for students.—*Dr. H. J. Cooper.*

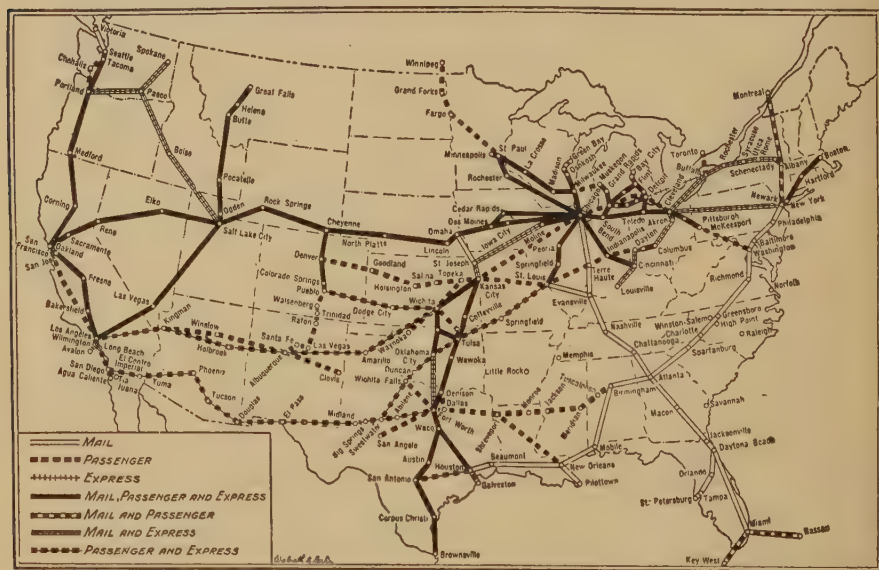
AIR TRANSPORTATION

A marked increase in scheduled air transport activities of United States air lines in the last four years is noted in a study of the growth of scheduled air transportation completed by the Aeronautics Branch of the department of commerce as by Clarence M. Young, Assistant Secretary of Commerce for Aeronautics.

The data obtained by the Aeronautics Branch, indicate beyond a doubt that

the study is the increase in the number of passengers carried. In 1926, there were 5,782 persons carried on the scheduled routes then operating, while in 1929, the estimated number was 150,000, or an increase of 2,492 per cent.

Air mail poundage during the four-year period increased from 810,855 pounds in 1926 to 7,700,000 pounds in 1929, while mileage flown by mail planes increased



Courtesy N. Y. Times

PASSENGER MAIL AND EXPRESS AIR LINES AS OF APRIL, 1930

scheduled air transportation no longer is in the experimental or novelty class, but is a valuable factor in the economic advancement of the nation.

The four-year period from 1926 to 1929, inclusive, was selected for the study because prior to the establishment of the Aeronautics Branch, which resulted from the enactment of the Air Commerce Act of 1926, complete records of such scheduled air transportation activities as were in existence are not now available.

Perhaps the most interesting feature of

from 4,240,407 miles in 1926 to 16,000,000 miles in 1929.

While the number of United States air transport operators increased from 18 in 1926 to 35 in 1929, a percentage of 94, the number of routes operated by these companies was developed from 18 to 97 or 439 per cent.

On December 31, 1926, there were 8,404 miles of airways operated by the air transport companies, of which 8,039 were for air mail. On December 31, 1929, there were 36,000 miles of airways in operation, of

which 26,597 miles were used by the air mail. The mileage actually flown by the operators increased 409 per cent or from 4,318,087 in 1926, with a daily average of 11,830 miles, to 22,000,000 miles in 1929 or 60,273 miles average daily. At the present time the daily scheduled mileage is 90,000.

The planes and personnel engaged in the operation of scheduled air transport activities increased from 128 planes, 127 pilots and 355 other personnel in 1927, to 525 planes, 500 pilots and 1,500 personnel in 1929.

A portion of the foregoing data on operations and equipment must be credited to air lines owned by United States companies which extend into foreign countries in the Western Hemisphere.

Of the 36,000 miles of airways operated during 1929, 11,456 miles were to Canada, Central and South America and the West Indies. Over these 11,456 miles of inter-

national airways, six United States air transport companies maintained 14 routes, carried 670,000 pounds of mail and flew 2,000,000 miles during 1929.

Development of these inter-American services has been satisfactory when compared with the 185 miles of airways operated from the United States during 1926 over which 55,839 pounds of mail were carried and 34,266 miles were flown by two operators. Comparable passenger, pilot and equipment statistics are not available due to the lack of sufficient reports.

The results of the study show that scheduled air transportation constitutes only 15 per cent of all civil and commercial flying activities in the United States. Studies covering the remaining 85 per cent—miscellaneous operations, which include student instruction, air taxi operations, aerial photography, crop dusting, experimental flying and private flying—will be announced later.

AIR TRAVEL

USEFUL FOR MANY PURPOSES

Occasions often arise where airplanes that ordinarily fly through the night with the airmail are pressed into emergency services, according to Eastern Air Transport, Inc. This Company operates the New York-Atlanta-Miami airmail route for the Government, but on its records are details of mercy flights, of races with time and railroad trains, and of flights with troubled folk to the bedsides of ill or dying loved ones.

When a section of its territory was cut off by floods, mail planes of Eastern Air Transport began an emergency service that restored communication to the area until surface facilities were restored. Two of its pilots sped from the opposite coasts of Florida to an inland town with serum for a girl who was near death. At dawn one morning a man boarded one of the

fast mail planes in Jacksonville, was flown to Atlanta and then on to a Tennessee city, where he arrived in time to be with his father at his death.

On another occasion one of the airmail pilots of the line broke speed records between Jacksonville and Spartanburg in flying a woman to the bedside of her ill husband. A man whose son was dangerously ill in New York of pneumonia boarded a mail plane in Florida for a race with a crack train that had started out hours before. The train was overtaken in South Carolina and the man boarded it in Charleston. More recently a special mail plane took off from Philadelphia and flew to Atlanta with 50,000 vials of smallpox vaccine, where it was put aboard the regular mail plane for Miami and Costa Rica, its destination.

AIRPLANE KILLS MOSQUITOES

The night airmail is doing something about the mosquito problem, although it is entirely unintentional, according to Eastern Air Transport, Inc. Countless insects, many of them the biters, nestle down in the velvety grass of airports. The mail planes drop in to take on and dis-

charge cargoes, then roar across the fields and into the air again. While the craft is thundering along the ground dozens of the insects "take off" too in an effort to escape the mysterious thunder that is bearing upon them. The airplane's propeller and wings become discolored with their blood.

CROSS-COUNTRY AIR RECORDS

Since the transcontinental crossing was first made by air eighteen years ago the time for the journey has been reduced from several months to half a day. The records and the pilots who made them follow:

1912—Bob Fowler, San Francisco to Jacksonville; 151 days.

1919—Belvin Maynard, New York to San Francisco and return; 22 days.

1923—Kelly and MacReady, non-stop, Roosevelt Field to San Diego; 26 hours 50 minutes.

1924—Russell Maughan, Mitchel Field to San Diego; 24 hours 48 minutes.

1928 (August)—Arthur Goebel, non-stop, Los Angeles to Roosevelt Field; 18 hours 58 minutes.

1928 (October)—C. B. D. Collyer and Harry Tucker, Roosevelt Field to Los Angeles, 24 hours 51 minutes.

1929 (February)—Frank Hawks non-stop, Los Angeles to Roosevelt Field; 18 hours 21 minutes 59 seconds.

1929 (June)—Hawks, same course, 17 hours 38 minutes 16 seconds.

1930 (April)—Colonel and Mrs. Charles A. Lindbergh, Los Angeles to Roosevelt Field; 14 hours 45 minutes 32 seconds.

1930 (August)—Hawks, Valley Stream to Los Angeles; 14 hours 50 minutes.

1930 (August)—Hawks, Los Angeles to Curtiss Field, 12 hours 25 minutes 3 seconds.

FLYING BELOW SEA-LEVEL

An interesting fact has been disclosed concerning the operation of aircraft from the landing field at El Lisan on the shore of the Dead Sea. This field is 1,000 feet below sea level, and a density of air results which acts as a mild supercharger on the engine, giving it an extra 250

r.p.m. An airplane's landing speed is reduced by 10 miles an hour and its high speed, evidently resulting from the extra r.p.m., is increased by that amount. Planes "land like a feather" in the great depression, it is said.

"BLIND" OR "INSTRUMENT" FLYING?

Modern Minds attach much greater importance to nomenclature than did Shakespeare, and feel that the query "What's in a name?" is not to be lightly answered. The Boeing Company, for example, insists that "blind" flying is a misnomer when applied to flying by instruments, and have abandoned the use of the term. If a pilot feels the helplessness that the idea of blindness conveys to the person of normal vision, they say, he had better descend forthwith. "Instrument" flying is, however, receiving an increasing amount of attention, students in the schools being trained to fly in hooded cockpits for long distances and over triangular or other irregular courses. The same practice has of course been extensively adopted elsewhere, especially by transport lines seeking to put a super-finish on the qualifications of their own personnel.

Pilots who have not been trained to depend on instruments are prone to become panicky after a few minutes without seeing their course. Those with only a limited experience find the nervous strain of long-continued instrument flying terrific. There are well trained and reliable pilots of the older generation who will insist that no one can fly solely by instruments for more than five or ten minutes without losing his nerve. Yet young students are learning to fly prolonged and irregular courses entirely by instruments in hooded

cockpits, and navigating with remarkable accuracy.

Colonel Lindbergh is reported to have said that one of the hardest things about his New York to Paris flight was to believe that the instruments were right when his personal feeling was that they must be wrong. Other pilots innumerable have told the same story. Navigators of long flights tell of the tendency of even the most experienced pilots of the older school to seek visibility, even at dangerously low altitudes, rather than fly through fog or clouds for even a few minutes. And there is little doubt that some of the regrettable transport accidents might have been avoided had the pilots of the planes been thoroughly trained in flying by instrumental guidance alone.

Dependence on instruments, however, places an ever-increasing responsibility on both the instrument manufacturers and on those who select the equipment. On the former to design and build instruments of the greatest accuracy and reliability. On the latter to select the best instruments obtainable. Only reliable products by makers with a reputation to sustain should be considered, and if the price is somewhat higher than for some alternative product it is a cheap form of insurance. Safety is at stake in the development and use of the most efficient, most reliable, and sturdiest aerial navigating equipment available.

GLIDER SOARS 15 HOURS 13 MINUTES

Failure to provide himself with a barograph robbed Jack Barstow, 24, of a new official world's record for sustained flight in a glider after he had soared over Point Loma for fifteen hours and thirteen minutes on April 30, 1930, in a motorless sail plane, exceeding all previous glider endurance marks.

This performance will stand only as an unofficial record because of rules requiring that a barograph be installed in aircraft in order to gain official acceptance of new records.

Barstow took off at 12:44 P. M., Pacific Standard Time, recently, in a new Bowlus sail plane of sixty-foot spread. He landed at 3:57 A. M., setting his craft down within 500 meters of his point of take-off.

The records exceeded are official American, 9 hours 5 minutes 32 2-5 seconds, established in March this year over Point Loma by Hawley Bowlus of San Diego; official world, 14 hours 10 minutes, established two years ago by Ray Schultz in Germany; unofficial world, 14 hours 45 minutes, established several months ago by Lieutenant Dinert, German glider pilot.

William Van Dusen, representing the National Aeronautical Association, witnessed Barstow's flight. He took steps to obtain statements and affidavits from others present so that the feat may be certified for its historical interest.

Barstow came to San Diego a few months ago from Charlotte, Mich. He holds a first-class license as a glider pilot.

AIRWAY WEATHER FORECASTS

The Weather Bureau is organizing a notable expansion of its service in aid of aviation, which will provide frequent and regular weather reports covering approximately 13,000 miles of airways. Effective soon after July 1, these reports will provide sufficient detail to meet all existing needs, the U. S. Department of Agriculture announces.

On about 8,000 miles of these airways teletype lines will provide 24-hour communication with exchange of reports once each hour. The remaining 5,000 miles will be served by reports transmitted by telephone or telegraph and at such intervals as will best meet current needs. On nearly 3,000 miles of airways, over which there is as yet comparatively little flying (one or two daily flights each way), the bureau will provide a limited service.

The current reports along all of these airways are supplemented by specialized, short-period airways forecasts which are based primarily on the twice-daily, country-wide reports and weather maps, used in the general forecasting service, and, secondarily, on a series of three-hourly reports concentrated at designated centers from a well-selected network of stations. Some of these reporting stations are on the airways and others are at a considerable distance from them. At present the centers to which these reports go and from which the short-period forecasts are issued are the airport stations at Cleveland, Ohio; Fort Crook, Nebr.; Salt Lake City, Utah; and Oakland, Calif. The increased appropriation will enable the bureau to open three new offices, at At-

lanta, Ga., at Dallas, Texas, and at Portland, Ore. About 110 reporting stations will transmit to these forecasting centers.

Bulletins and short-period forecasts based on these reports will be sent by teletype from the seven centers to other airports and to landing fields and will also be broadcast to aircraft in flight through a rapidly expanding network of radio stations maintained by the Department of Commerce.

The Weather Bureau's program provides for the establishment of observation from pilot balloons at several additional stations including Albuquerque, N. Mex.; Cincinnati, Ohio; Dallas and Del Rio, Texas; Elko, Nev.; and North Platte, Nebr.

Outside of continental United States, the bureau is increasing its airways service in Alaska, where a new first order station is being organized at Nome. Pilot balloons will be stationed at Nome and Fairbanks. The service in the Hawaiian Islands will include a chain of inter-island stations from which reports will be transmitted by radio to Honolulu, there to be made available for the information of pilots flying from one island to another.

The Weather Bureau also announces that it is continuing its investigations with kites, captive, pilot and sounding balloons and airplanes (through cooperation with the Navy Department), and is now engaged also in studies of ice formation on aircraft, turbulence or gustiness and other problems. The bureau's appropriation for all phases of its airways forecasting and study is \$1,400,000.

VITAMINS IN WATERMELONS

Refreshing, juicy, fine-flavored watermelons have still another virtue for the consumer who is interested in food values. Watermelons have been found, by the Bureau of Home Economics of the United States Department of Agriculture, to be a good source of two important vitamins, A and C, and to contain detectable amounts of vitamins B and G. The growth and good physical condition of the laboratory animals in the tests for each vitamin indicated that the watermelon in their diets supplied the vitamin being studied. All

the experimental animals ate the watermelon readily, and the guinea pigs developed a keen watermelon appetite.

The feeding experiments were confined to the Tom Watson variety of watermelon, which makes up about 90 per cent of commercial shipments. Other red-fleshed varieties are similar to the Tom Watson in structure and are similarly handled, so it is believed that the results of this study apply to the watermelon crop as a whole.

AIRPLANE MODEL INDUSTRY

Colonel Lindbergh's international flight in May of 1927 turned the youth of America airminded as well as the adult population. Three leading manufacturers of toy construction sets seized upon the wave of youthful enthusiasm, practically abandoning their old lines of mechanical sets, by the sale of all-metal model aircraft kits, totaling over \$300,000 retail business by the end of 1927. "Spirit of St. Louis" was registered as a trade name for certain models.

The year 1928 saw real expansion as some 2,000 rivals, ranging from "base-ment" factories to large corporations, woke up to the possibilities of aircraft model manufacture as a new industry. A large St. Louis firm did \$400,000 in wholesale that year, with \$1,500,000 accounting for the rest of the industry. And 1929 saw the entire industry soaring, with one firm doing \$140,000 (wholesale) for the month of October. The investment for the industry is now about \$4,000,000.

William B. Stout of Stout Trophy fame, general manager of Stout Metal Airplane Company, airplane division, Ford Motor Company, organized the first boys' model aircraft club in the United States from Chicago high school boys. This was shortly before the World War, but the war naturally spoiled the plans for nation-wide expansion of boys' aircraft clubs. But from this first instance of aeronautical education for our youth, two of the early members are represented in the present airplane manufacturing field.

MOVEMENT HAS WIDE SPREAD

The National Aeronautical Association authorized two contests for model aircraft construction. The Mulvihill contest for outdoor flying models is held, together with annual national air races and expositions, in the cities which sponsor them. The Stout Trophy and \$500 in prizes is open yearly to cities wishing to conduct indoor model contests.

Sectional aircraft tournaments were held by the playground and recreation associations in different cities, local contest winners meeting in final competition at Memphis, Tenn., in 1927. The national

Y. M. C. A. organization fosters similar contests, offering annual prizes to youthful model builders, as does the Boy Scouts of America.

Furthering the educational influence of these associations, vocational departments of public schools in Cleveland, Detroit, St. Louis and other cities furnish practical acquaintance with aviation fundamentals in such a manner that it is sure to be grasped through model building.

The Airplane Model League of America was organized by The American Boy Magazine, with the support of the N. A. A., to further interest in and knowledge of aviation through the building and flying of scientific model airplanes. The First and Second National A. M. L. A. contests were held in Detroit in 1928 and 1929, providing free trips to Europe for national champions, as well as more than 300 prizes in cash, medals, cups, scholarships and other awards.

World's Air Fair Week at St. Louis, Mo., from Feb. 15 to 23, 1930, witnessed unusual competition for the Stout Indoor Model Trophy. Nearly 7,000 entries were received from all parts of the country. This second International Aircraft Exposition sponsored by the Aeronautical Chamber of Commerce gave birth to a new Junior Aircraft Convention.

All entrants in the model contests at St. Louis also heard noted speakers on aviation topics on the program given by the National Conference on Aeronautical Education.

ACTIVITY CREATES INDUSTRY

Gradually growing in its popularity since 1918, juvenile aircraft activity has now reached the place where it has national significance, both as an educational force and as an industrial necessity. With literally millions of boys in the United States building model aircraft, a large portion of which actually fly, there has been created a steady demand for supplies like very light balsa wood for propellers and fuselage frames; rice paper for wings and bodies; power motors of rubber, compressed air, or gas design; extremely

lightweight metal for all-metal flying models, and all the kindred supplies necessary for assembling models.

Nor have the manufacturers overlooked an opportunity to be of genuine service, for a St. Louis firm, backed by Messrs. Knight, Bixby and Dysart, who were of the original group that financed Colonel Lindbergh, launched the Lyonsport Aero Clubs in 1928.

This national organization of air-minded boys is conducted by Captain Jack Bursey, British war ace, and has members

in twenty-four countries outside of the United States. Lyonsport hour at 5:30, Central Standard Time, over radio Station KMOX, Voice of St. Louis, is of especial interest to members and all youth interested in juvenile aviation. The winged "Pilot" emblem admits members free to certain war-air motion pictures shown yearly by a large film corporation, and also entitles them to a free course of ground lessons in aviation at Parks Air College, near St. Louis.—*W. G. Neptune in N. Y. Times.*

JUDGING WIND VELOCITY

A "rule of thumb" system devised by the United States Weather Bureau enables anyone to make a fairly accurate estimate of the wind velocity, even when he is miles from a weather bureau station.

When the wind blows less than 1 mile per hour, smoke rises vertically. A wind of 1 to 3 miles causes smoke to drift but does not move a wind vane. A light wind of 4 to 7 miles makes itself felt on the face, rustles the leaves and moves a wind vane, while a gentle breeze of 8 to 12 miles an hour keeps leaves and small twigs in constant motion and extends light flags.

A moderate wind of 13 to 18 miles an hour raises dust and loose paper and moves small branches, while a "fresh blow" of 19 to 24 miles causes small leafy trees to sway gently and forms crested wavelets on inland waters.

A strong wind of 25 to 31 miles an hour moves large branches of trees, whistles through the telegraph wires and makes it difficult to hold an umbrella open, while a

wind of 32 to 38 miles velocity sets whole trees in motion and retards anyone walking against the wind.

A wind blowing 39 to 54 miles an hour is known by the Weather Bureau as a gale. When a gale does not exceed 46 miles an hour it breaks twigs off of trees and generally impedes progress, but when stronger it causes slight structural damage, blowing off chimney pots and slate shingles.

The wind seldom blows 55 to 75 miles an hour inland, but such a velocity is known as a "whole gale." When blowing at a velocity of 55 to 63 miles an hour, a "whole gale" uproots trees and causes considerable structural damage, and a 64 to 75 mile "whole gale," very rarely experienced, causes widespread damage.

A hurricane, blowing faster than 75 miles an hour, makes itself known with a fury understandable only by those who have lived through such an experience.

GLIDERS AND GLIDING

It is the aim of the Aeronautic Branch of the Department of Commerce to encourage the development of gliding in the United States not only as a sporting and recreational activity, but as a medium for furthering interest in all phases of aeronautics.

To this end, the Aeronautics Branch issues a bulletin which deals with the subject of gliders and gliding in general terms. The bulletin is not to be interpreted, however, as constituting an instruction book for glider operations.

HISTORY

The glider and the art of gliding abound in historical significance. But it was not until the early nineties that the glider took on serious proportions. At that time, civilization had progressed to the point where farsighted individuals saw the age of human flight in powered craft just beyond the horizon.

While the glider was in existence in one form or another prior to 1890, the events that followed the experiments with gliders in the nineties and which culminated in the first flight of a powered machine carrying a human being were of such outstanding importance that it would seem the art, science, and sport of glider operation may well be dated back to just a few years before the dawn of the twentieth century.

Otto Lilienthal, of Germany, one of the outstanding pioneers in gliding, between 1890 and 1896 made many successful flights with gliders, covering distances as great as 1,000 feet from the point of take-off. With the glider, he was in search of what we have today—the airplane. The glider was regarded as the stepping-stone in the eyes of those pioneers, and a correct and reliable stepping-stone it proved to be.

While Lilienthal was conducting glider experiments, others interested themselves in this form of flying. Among those whose work is a matter of history are Percy S. Pilcher, of England; Voisin and Farman, of France; and John James Montgomery, Octave Chanute, and A. M. Herring, of the United States.

WRIGHT GLIDERS

In 1900 the Wright brothers constructed and flew gliders to aid them in their search

for the realization of their dreams. The Wright gliders appear to have been the first in which the landing gear was employed. These gliders used skids which are standard equipment on many of the present-day types. In employing the skids, the Wrights obviated the necessity for using the feet in landing, which was a feature of the "hang type" then in vogue. The "hang type" called for the suspension of the glider pilot from his armpits, in order that he could use his feet as power for taking-off, as a means of alighting on the earth, and as a means of balance in the air.

In 1905 John James Montgomery was conducting experiments with gliders which embodied complete control surfaces, such as warped wings, rudders, and elevators. Montgomery's experiments with gliders in general began about 1880.

A distinctive feature of the work of Montgomery was the method he adopted for launching the gliders. He took off from hot-air balloons. Thus, the feat of Lieut. Ralph S. Barnaby, United States Navy, of being launched in a glider from the rigid airship *Los Angeles*, was not entirely without precedent. Montgomery is credited with having taken off from balloons at altitudes ranging from 1,000 to 4,000 feet, while other glider advocates were content to use hills as their starting point.

Montgomery, aside from deriving certain remuneration from his gliding activities at public exhibitions, used the glider for studies in aerodynamics.

In 1911 Orville Wright returned to Kitty Hawk with a glider to conduct further flight experiments on automatic stability devices for airplanes. In connection with these flights, he established a duration record of 9 minutes and 45 seconds, which remained unbroken in this country until 1928.

GLIDER CAMP ESTABLISHED

In 1912 a glider camp was established at Rhön, Germany, but it was not until after the World War that widespread activity took place there. The hill which was the site of the first camp now is marked by permanent buildings, housing schools and accommodations for glider enthusiasts.

Between 1912 and 1914 in the United

States there was some activity in gliding. Numerous plans and specifications became available for the manufacture of biplane gliders and at least one company established itself on record as manufacturing these craft. Virtually all of the plans were for the "hang type" glider.

The World War served to detract interest from gliding which did not resume in the United States until 1922, when a glider club was formed at Massachusetts Institute of Technology. One of the members qualified to participate in the annual Rhön competition, which marked the turning point in gliding accomplishments. Heretofore flights had been comparatively brief in duration, but during the competition they were extended into periods of hours.

Once again the gliding activity in the United States lapsed only to be revived again in 1928 with the arrival at Cape Cod of several German glider experts, one of whom, Peter Hesselbach, established a duration record of more than four hours, thereby breaking Orville Wright's record of 1911.

By 1930 the glider movement in the United States was well under way. From 10 to 15 companies were manufacturing gliders; glider clubs had been formed and still are being organized; the record flight of Hesselbach at Cape Cod was broken by Bowlus, an American, with an American designed and built glider (soaring plane or sail plane); a glider was launched from the *Los Angeles*, and a glider was towed across the continent by an airplane. An added impetus was given to the movement by the glider flights of Col. Charles A. Lindbergh.

PURPOSE

What is the purpose of gliding, and what relationship has it to aeronautics?

Gliding is great entertainment and great sport. But it goes farther than that. It offers a stepping-stone leading to subsequent training in the engine-driven plane. Specifically, primary gliding is a training for advanced stages of gliding and the most difficult and yet most fascinating of all phases of this activity—soaring.

When the glider pilot graduates into soaring, he enters the field of meteorology, topography, and expert airmanship. To remain aloft for hours at a time in a

motorless heavier-than-air aircraft calls for a working knowledge of these subjects. The rewards for the efforts expended are the accomplishments.

It took the glider pilots at the Rhön five years to learn to soar for several hours. They developed cloud flying by utilizing the currents peculiar to cumulus clouds. These currents have an upward trend, culminating in the clouds. Immediately beneath the clouds the movement is sufficient to enable the motorless plane to hold its altitude.

The other type of soaring flight calls for the utilization of ground currents found over rough terrain. A skillful pilot may employ these currents as they rise over the edge of a hill or ridge to great advantage and may "crab" along the peak of the hill or ridge, back and forth to his heart's content.

TYPES OF GLIDERS

A glider may be described as an airplane without engine and reduced to the simplest elements. There are three types: (1) Primary glider, (2) secondary glider, and (3) soaring plane.

The primary glider is just what its name implies. It is the starting point, the beginning.

The secondary glider is for those who have achieved the lessons taught by the primary. It has a better gliding angle, is of lighter construction and will not stand the abuse that the primary is subjected to during the training periods. Whereas the primary glider has a gliding angle of about 8 to 1 (it will glide forward 8 feet while losing 1 foot of altitude), the secondary is credited with having a gliding angle of from 12 to 15 to 1.

The third type is the soaring plane, sometimes called soarer or sail plane. This craft, of refined construction and extremely light in weight, has a gliding angle of about 20 to 1. These planes are used in record-breaking attempts for duration and altitude.

INSTRUCTION

Flight instruction on motored aircraft is treated with great respect. Many weeks are usually devoted to practice flying before the student is eligible to take the Department of Commerce examination for a private pilot license.

Generally there is no difference between

being aloft in a glider and an engine-driven plane, except that in the latter case the student, in the early stages of training, has an instructor present to correct any serious mistakes.

Owing to the limited load-carrying capacity of most types of primary gliders, instructors can not go aloft with the glider student. However, this condition is expected to change as time goes on so that students will have personal instruction in the air.

Pending the arrival of the day when a glider student will not have to go aloft alone he should be thoroughly drilled in the manipulation and significance of the controls before making his first flight. His first trip in the air is no occasion to learn for the first time what will happen if the stick is pulled back, or pushed forward, or moved to the right or left.

There are three methods of glider training which may be followed with success as long as airworthy gliders and competent instructors are involved. One is to launch the glider by means of an elastic cord from a small hill; another is to launch it from a flat surface by the same method; and the third is by automobile towing from a flat surface. The launching of gliders from water by speed boats, is somewhat similar to automobile towing. Towing of gliders by aircraft is prohibited except by special permission from the Secretary of Commerce.

LAUNCHING FROM HILL

The launching of gliders from a hill by the elastic-cord method is perhaps the most elementary and yet most satisfactory method of teaching beginners. Particularly is this true if the glider club or group participating in the activity is fortunate enough to obtain the use of a hill with a gradual slope. In this event, the result is quite comparable to sliding down hill except that the glider always is above the ground, provided of course the gliding angle is not less than the grade of the hill.

To be launched by the elastic-cord method from a hill requires the participation of several persons. The elastic cord is secured at a point directly in the nose or bow of the glider fuselage framework and is subject to automatic release when the tension on the cord is relaxed. It then is carried out in a V shape, the glider being

at the apex of the V. The rear of the glider either is held down by man power or is tied to a post driven in the ground with a snubbing device that can bring about its quick release.

On each end of the V-shape cord, there should be not less than three persons. On a given signal, they walk away from the glider, stretching the cord as they go. When the desired elasticity of the cord is approached, the person in command of the flight (either the instructor or the pilot at the controls) shouts, "Run!" At about the same time the forces holding onto the rear of the glider are released, the glider is catapulted into the air as the crew runs with the cord and the glider takes off straight ahead with no danger of alighting in the midst of the crew, who by their V-shape formation have moved far out of the direct course contemplated by the glider pilot.

No sooner is the pilot in the air than his thoughts turn to making a landing. If the gliding angle of the craft is high, and the slope of the hill compares somewhat favorably with that angle, the glide will be longer than if the launching took place on a flat surface. In cases of a straight flight, the glider launched from a hill will land at an altitude below the point from which it took off. In launching from a flat surface, obviously the operation is reduced to a sudden climb into the air and then a descent.

GLIDING IN FLAT COUNTRY

In flat country, various methods have been and constantly are being devised for the launching of gliders in addition to the hand-operated elastic-cord practice as heretofore described. These include the employment of an automobile to stretch the cord to the desired tension; devices for holding down the tail which automatically release the glider when a certain tension is reached; and a "sling shot" method whereby the glider, attached to an elastic cord with ends made fast to the ground, is pulled back and released into the air. In both the mechanically and manually operated devices, there may be found provisions for regulating the amount of tension and thereby controlling, to a great degree, the force which catapults the glider into the air. This in turn gives a certain amount of

control over the altitude or distance the glider is to fly.

Elastic-cord launching offers great possibilities for glider training without any unusual hazard. Because it is primary and elementary, it should not be ignored or passed over lightly. Especially in the case of a person with no previous heavier-than-air aircraft experience, this method constitutes the very foundation for the future stages of glider flying into which the student wishes to progress.

Automobile towing offers greater possibilities for longer time in the air, more manipulation of the controls and the attempt at slight turns and banks as proficiency increases. In towing, the student should be taught the smooth and easy use of the controls by being towed just under flying speed. As the student becomes proficient, the speed of the automobile should be increased gradually until the glider is from 3 to 6 feet off the ground and then decrease until the glider again touches earth. This practice is repeated until the student has the "feel" of flying and landing.

CAR DRIVING IMPORTANT

The driver of the car always should slow down when the glider fails to follow the path of the car either on the ground or in the air. At no time should the driver of the car permit the student to hold an excessive angle of climb without stopping to correct him.

Gliders always should be towed directly into the wind. Immediately before the flight is to start, the slack should be taken out of the cable or tow line to prevent breakage or jerking the glider. While towing, the driver of the automobile should be careful to shift the gears of the car smoothly in order to maintain steady acceleration. A glider should never be towed at excessive speeds.

Of the three general methods of glider launching, automobile towing should be given the most careful consideration as there is greater liability of damage to the craft or injury to the pilot through this method.

Automobile towing should not be undertaken unless there is some one in the towing car who has had experience with this form of launching. This experience is necessary because the towing car is in an ex-

cellent position to regulate the flight of the glider, by slowing down, speeding up, or stopping altogether. The occupants of the car bear as close a relationship to the glider pilot as the instructor who rides in an engine-driven plane with a student.

SAFETY PRINCIPLES

Airworthy gliders under the supervision of experienced glider pilots who are competent to give instruction, serve to bring about a realization of all the good points in gliding activities. Without competent supervision and instruction gliding may become exceedingly dangerous even though no doubt exists as to the glider's condition of airworthiness.

If gliders are to be constructed by individuals, clubs, or other groups interested in gliding, a skillful aeronautical designer and constructor should be obtained to supervise the work from the drawing board to the test flight. If such assistance is not available, then the gliders should be acquired from reputable and reliable sources.

The primary gliders should be acquired first, unless the prospective purchasers have qualified on this type. It is a waste of time and money to construct the lighter types, owing to the hard usage to which they are subjected during training.

In purchasing gliders, it would be well to determine in advance if they have been granted approved-type certificates by the Aeronautics Branch of the Department of Commerce, or if they are eligible for license. If they have the approved-type certificate or are eligible for license, they, therefore, bear the Government's stamp of approval as to airworthiness.

Once all doubt has been removed as to the airworthiness of the gliders, careful consideration should be given to the competency of the instruction. Successful gliding can not be accomplished without a close coordination of the two essential elements—airworthy gliders and competent instruction.

LICENSING

The glider movement in the United States is attracting the attention of hundreds of people, many of whom are in search of information concerning the construction, operation, and licensing of gliders, as well as information involving instruction, student permits, and glider pilot licenses.

This condition, together with the fact that more than a score of States require Federal licenses for aircraft and airmen, has caused the Aeronautics Branch of the Department of Commerce to recognize the existence of a need for Federal interest in gliders and gliding. This interest takes the form of new regulations governing the licensing of gliders and glider pilots.

In drafting the new regulations the department has made a sincere effort to further the gliding activity in all its phases. The regulations aim to provide for the elimination of probable sources of danger in gliding, which always will exist unless there is intelligent care and attention given to the construction, maintenance, and operation thereof.

The regulations embody the following provisions:

Three classes of gliders will be considered eligible for license and will be licensed upon passing an inspection by the Department of Commerce. The three classes are:

1. (a) Gliders manufactured under approved-type certificates. This corresponds to the present procedure involving the licensing of airplanes which are built under approved-type certificates.

(b) Gliders constructed by anyone, provided they are built in accordance with specifications and designs which have been previously approved by the Department of Commerce.

2. Gliders not manufactured under approved-type certificates but which meet the requirements for such a certificate.

3. Gliders not included in either class 1 or 2 will be eligible for license provided they pass a visual inspection by the Department of Commerce as to design, materials, workmanship, and flight characteristics, and provided they were manufactured prior to October 1, 1930.

Gliders under class 1 (a) are those manufactured in quantities by holders of approved-type certificates for the type of gliders they are building. Such gliders shall be exactly similar in specifications, design, and workmanship to the type approved by the Department of Commerce.

Gliders under class 1 (b) are those manufactured by private owners or others who have followed previously approved specifications and design, such as gliders

manufactured from the drawings of an approved-type glider, provided, of course, the holder of the approved-type certificate sees fit to distribute such drawings.

Gliders manufactured under class 2 are those which meet all of the minimum requirements for an approved-type certificate, but for which a certificate is not desired because quantity production is not planned.

Gliders under class 3 include those built by individuals and clubs with or without previously approved designs, provided they were manufactured prior to October 1, 1930. Their eligibility for license will be determined by a visual inspection of the design, materials, workmanship, and flight characteristics according to a "rule of thumb" method which has been devised by the department. Gliders so constructed after October 1 will not be considered eligible for license.

Three types of glider-pilot licenses are provided for—student, noncommercial, and commercial.

Glider-student permits, authorizing the holder to receive instruction and to solo licensed gliders while under the jurisdiction of a licensed glider pilot, will be issued by Department of Commerce inspectors and department divisional offices upon application. No physical or written examination will be required. A form has been drafted which is both an application and student permit, a perforation permitting their separation. These forms may be obtained from any Department of Commerce inspector or divisional office.

The noncommercial glider license will serve the group that is desirous of operating gliders only for sport and pleasure. This license parallels, to a degree, the private airplane pilot license. The only examination required for this license will be a flight test which will consist of a minimum of three flights including moderate banks in either direction. Applications for noncommercial glider licenses may be made on regular pilot application forms obtainable from department inspectors or divisional offices.

The commercial glider pilot license will be issued to all applicants physically qualified who successfully accomplish the flight test involved. Applicants for the commercial license are required to pass a physical examination the same as is now required

for the private airplane pilot license. There is no written examination.

The flight test for the commercial glider pilot license, in addition to normal take-offs and landings, includes a series of general and moderate banks, 360° turns and precision landings.

The glider pilot licenses will be issued to all grades of airplane pilots upon a

satisfactory completion of the tests involved.

Applications for the commercial glider-pilot license also may be obtained from department inspectors or divisional offices.

Glider and glider pilot licenses are mandatory in States requiring Federal licenses for aircraft and airmen.—*Bulletin Aeronautics Branch, Department of Commerce.*

GLIDER RECORD

Racing ninety-four miles before a thunderstorm in a frail little glider, Robert Kronfeld, Austrian, bettered his former world record for distance flying on August 14th by nearly two kilometers (about 1¼ miles).

Other pilots participating in the international soaring competition had landed, unwilling to fly in the approaching storm. Kronfeld decided to go aloft and "hooked on to" a cloud that was sweeping over the mountains.

He landed at Hof, near the spot where he set his previous record last year. Pilot Hurtigg of Cassel covered forty-two miles.

Herr Kronfeld has been one of the outstanding exponents of motorless flight for many years. He has held records for gliding in altitude, distance and duration. With an accurate knowledge of the invisible currents of the upper air he has evolved

and proved theories of motorless aviation over certain topographical conditions. His flight before the storm on August 14th was made by taking advantage of the upward air currents which are usually present beneath cumulus clouds driven before severe storms. Ascending to the full advantage of each current, the pilot picks out a cloud ahead and dives.

With the wind on his tail he travels faster than the following storm, gains his objective and repeats the operation. In such manner Kronfeld established his previous record of ninety-three miles last year above the Rhone Mountains in South Germany. He also made a startling demonstration last year when he flew a straight line course over flat country in England, covering seventy miles by "hooking on to the clouds." His altitude record of 9,780 feet, made in a glider at Gersfeld, Germany, on July 31, 1929, still stands.

ALPHABET LETTERS PICTURE MOUTH

When man first started to write, the forms he made were in imitation of the shape of the mouth in speaking. This theory has been advanced by Sir Richard Paget, famous authority on speech.

When the various alphabets of the world are examined, Sir Richard explained, the symbols for M almost invariably represent two closed lips which is the position of the mouth in pronouncing that letter. B also shows the two closed lips in profile.

In the English alphabet nearly all the

letters thus picture the mouth in speech. The letter A, formerly written on its side, represents an open mouth, the letter O, the rounded mouth necessary for pronouncing that letter. The upright letter I with the dot over it represents the raised tongue not quite touching the palate. In the letters L and T the contact of the tongue with the palate is actually made. Though these letters sound so different, they are made by the tongue in very much the same position. And the symbol L is almost the same as a T inverted.—*Science Service.*

THE YEAR IN AVIATION

AIRSHIP PROSPECTS AND PROGRESS

Airship enthusiasts have been greatly encouraged by the year's developments. In Akron, under the auspices of the Goodyear-Zeppelin Corporation, the 6,500,000 cubic-foot airship *Akron* is advancing rapidly. Seven main frames, and eighteen intermediate frames are in position, representing 525 feet of the ship's total length of 785 feet. This dirigible has been called the "airship of 6,500,000 rivets"; stood on end it would be equivalent to a skyscraper of 80 stories. Fortunately driving rivets in the airship is not the noisy process we associate with the construction of a skyscraper. The dural rivets, heat-treated in an electric furnace, are taken from the furnace immediately quenched and then simply squeezed into position by a manually operated tool.

The airship is to be delivered to the Navy Department in the spring of 1931. With its swivelling propellers, speed of 80 miles per hour and unequalled dimensions, the *Akron* will mark a distinct epoch in airship development.

There are at present only two airship building corporations of importance in the United States. One of these two, the Aircraft Development Corporation of Detroit is actively pursuing its experiments with the metal-clad type of airship in which a thin metal covering of about 8 thousandths of an inch in thickness replaces the conventional rubberized fabric covering of today. The metal clad airship built by this company and delivered to the Navy's Airship station at Lakehurst, has shown up excellently in service and has successfully demonstrated that the difficulties expected from the very thin metal covering are really non-existent. It is understood that the du Ponts in conjunction with yet another lighter-than-air company are producing a wonderful synthetic material which will replace the expensive goldbeaters' skin (made of animal entrails) and will reduce the permeability of the gas bags to helium to an almost negligible quantity.

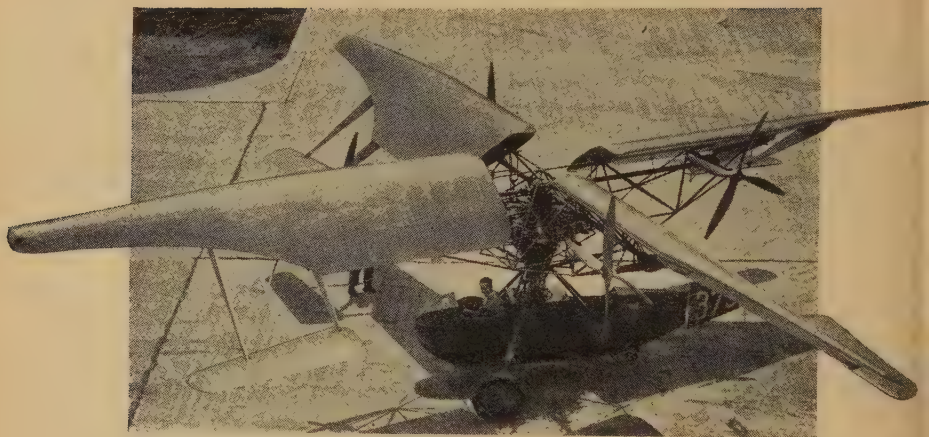
Small airships for private or commercial use have been few in number to date.

Still they have possibilities, and it is intriguing to learn that Captain Anton Heinen, the airship pilot employed by the Navy Department in the construction and operation of the Shenandoah, is planning to build a number of small airship yachts. These little airships are to be only 104 feet in length with a gas capacity of 39,600 cubic feet. They are designed to have a top speed of 65 miles per hour and are to cost less in operation than an automobile! The plans also call for the use of a detachable passenger car which can operate under its own power as an automobile.

This of course would meet the great difficulty of transportation to the airport. It remains to be seen whether the technical difficulties involved in such independent operation can be overcome.

Still another encouraging feature of the airship situation is the fact that the proposed airship line between Spain and South America, under combined German, Spanish and South American auspices is apparently coming to a head. At any rate Captain Eckner, full of energy and enthusiasm after his successful voyage round the world, has definitely begun the construction of an airship for this service. The new airship the *LZ-128* is to be finished by the end of next summer. She is scheduled to be 815 feet in length, with a maximum diameter of 130 feet, and a displacement of 5,250,000 cubic feet. Four power gondolas are to be placed on either side of the airship, each equipped with two Maybach motors of 500 horse-power. The airship is planned to be used mainly for mail purposes and is not to be equipped with any degree of luxuriousness. The Spain-South America line is regarded as even more promising a field for the airship than the Germany to Lakehurst route, because the saving of time over the seventeen day steamer service is likely to be overwhelming.

The British on the other hand are more than satisfied with the flight of the *R-100* from Cardington to Montreal and back. The voyage from East to West, beginning on July 29th, took 79 hours of flight, with eight hours delay due to repairs in



CURTISS BLEEKER HELICOPTER

flight. The return trip of 57 hours 5 minutes was very close to the record time of the Graf Zeppelin. The *R-100* navigated successfully through fog, and when it was encountered on the voyage also demonstrated the success of a very useful new device whereby water deposited on the cover was collected by a series of special drains leading to a cistern. More than two tons of water were collected in this manner in the course of one morning. This ship was constructed by the Airship Guarantee Company of which Commander Sir C. Dennis Burney is the guiding spirit. As the result of close analysis and of the experience achieved in this successful voyage, Commander Burney predicts large profits on the investment in a regular line.

The trip of the *R-100* constitutes the eleventh crossing of the North Atlantic by airship, with some minor mishaps it is true, but with not a single fatality on any of the crossings. There would appear to be a good deal in favor of the opinion that the airship is a suitable medium for trans-oceanic travel.

THE HELICOPTER

The year has been marked by comparatively little news of helicopter development, with one outstanding exception, the announcement of completion of the Curtiss-Bleeker Helicopter. The possibilities of the helicopter or direct lift type of aircraft are very great. It is obvious that the

ability to rise vertically from a small plot of ground and to land at will in equally restricted territory is very valuable. While it is inconceivable that the helicopter should compete with the airplane for load carrying at high speed, it would be a very valuable auxiliary in air transport work. For military or naval air forces the helicopter's ability to hover over one spot would ensure accurate and deadly bombing. With these possibilities in mind much money and effort and ingenuity have been spent in all civilized countries on the production of a helicopter. Nowhere have really conclusive results been yet reached. For detailed description of the above helicopter see *Scientific American*, September, 1930, page 214.

NOVELTIES AND INVENTIONS

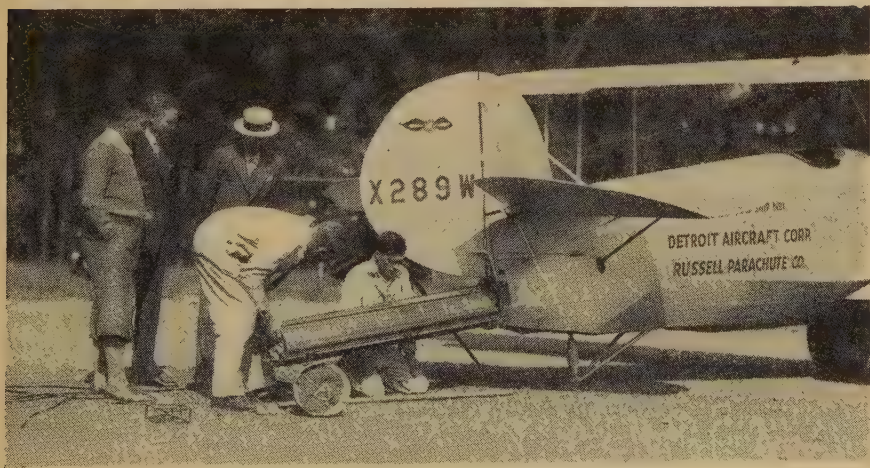
As aeronautics progresses more and more, it cannot be expected to provide us with so many thrilling novelties as in the past. Still there have been a good many novel developments even in this year of general aeronautical depression. One of the most striking is the provision of a parachute for the support of the entire plane, developed by the Russell Parachute Company and successfully tested on a Parks biplane of the Detroit Aircraft Corporation. The Parks biplane as used in this experiment weighs 1,800 pounds. The chute is carried in a tube built into

the bottom of the fuselage and is operated by a release cord in the pilot's cockpit. When the cord is pulled, the tube cap, containing the pilot chute is ejected, opening as the slack on the cables attached to the large chute is taken up. The small pilot chute is 18 feet in diameter and is designed to bring the plane to normal flying position from any maneuver before the large chute opens. As the pilot chute fills with air, the tension brings the main 60 feet chute from its tube and this brings the whole plane to earth at a speed of some 16 feet per second which, while high, is sufficient to ensure safety. The main chute is attached to four fittings on the center section of the top wing. The weight of the entire apparatus is less than 100 pounds. On the first test, the ship landed in a tree, yet the only damage sustained was that of a broken propeller and a bent landing gear axle. There is no doubt that if the plane chute proves entirely practicable it will add greatly to the confidence of the traveling public.

At the same time manufacturers are not neglecting other ways of providing parachute facilities for the traveling public. For example quick-release parachutes have been successfully tried out in recent months. The traveler is provided with a comfortable though sturdy jacket at the front of which there is a ring. The parachute is placed conveniently at hand

in the cabin, and a hook on the parachute can be attached to the ring in an instant. It is true that only a few weeks ago a girl of sixteen jumping from a cabin plane forgot to pull the rip cord and was killed, and it is true that passengers as a group will not take readily to the parachute. Still its possibilities in emergencies are well worth experimenting with.

The only type of aircraft we can recall which may be classed as completely a novelty is the rotor seaplane recently built at Mamaroneck, N. Y. Considerable mystery attaches to the construction of this seaplane. Instead of the ordinary wings, two cylinders or rotors are placed above and on either side of the fuselage, and are turned by gearing from a second engine placed in the fuselage, while another engine drives a conventional propulsive propeller. When the rotors are turning and the seaplane as a whole is in forward motion the rotors give a powerful upward or lifting force. Their action is similar to that of the Flettner rotors used in the Flettner rotorship, *Buckau*. While the daily press grew quite excited about the possibilities of the rotor airplane, it must be remembered that while rotors are very powerful in lift, far more powerful than ordinary wings of the same area, they are also far less efficient. That a rotor airplane can be made to fly is quite likely. That a rotor airplane can



RUSSELL PARACHUTE TO LAND ENTIRE PLANE

be made reasonably efficient is very doubtful.

AIRPLANES

The year's activity in design although somewhat curtailed by the general slump in aviation has brought out several new types of planes. The Daniel Guggenheim Safe Aircraft Competition was instrumental in bringing out the Curtiss "Tanager" the prize winning plane of the competition. This plane has brought several fine

streamline wire. The landing gear of the "Mystery S" is of very unique design.

A decided trend toward increasing the payload with increase in size of the ship, has been confirmed by the construction of several large ships. There is the Junkers G-38 which has undergone several successful flights at Desau, Germany. Although the construction of the G-38 is of usual Junkers metal type, the depth of wing is such that the power plants and



AIRPLANE USING FLETTNER ROTOR PRINCIPLE

developments to the eyes of the designer, notably the slots, flaps and floating ailerons. The added lift and speed range due to the slot and flap combination has proved very encouraging.

In the light racing and sport plane field, the "Mystery S" a low wing monoplane designed by the Travel Air Company has created quite a stir. The "Mystery S" is a typical low wing monoplane streamlined to the highest possible degree. It has incorporated every known device for the reduction of drag, such as tapered wings, wheel fairings, elliptical fuselage section and filleting of all sharp corners. The streamlining of the fuselage is carried through to the rudder the bottom of which conforms with the shape of the fuselage. The amount of external bracing has been cut to a minimum and where necessary is has been done through use of

cabin passenger accommodations are wholly contained within it. Propellers are mounted out in front of the wing on streamlined bosses and driven by extended shafts from the motor. The plane will carry 32 passengers together with a cargo of freight and mail. Passenger cabins in the wings are available.

In America, the Fokker Company has developed the F-32, a large monoplane of usual Fokker construction carrying 32 passengers and having a payload of 8700 lbs. The plane is driven by four tandem motors mounted out under the wings. Passenger accommodations are very luxurious and are capable of being made up as a pullman for night service.

The Commodore flying boats which have been constructed by the Consolidated Aircraft Company and put into service on southern routes of the N Y R B A Lines

are also additions to the large plane class. These planes are also luxuriously equipped for 20 passengers and can be made up for night service.

AERODYNAMICS OF THE AIRPLANE

In the aerodynamics of the airplane there have been no revolutionary changes, but steady refinement and improvement. The ideal of the airplane designer is a flying wing, with everything enclosed as far as possible in the wing itself. The Northrup Company of California has carried us a step nearer this ideal. Northrup has designed a pusher airplane, very heavily tapered from root to tip, so that the root of the wing is quite thick, so thick in fact that the small nacelle in which crew and engine are placed, is practically hidden in the wing. The Northrup Flying Wing is a pusher, with the propeller mounted behind the wing, and the tail surfaces carried on outriggers running from the wing. This is a decided step forward.

Vincent J. Burnelli has continued his experimental work with a transport plane in which exceptional cabin space is provided. The Burnelli fuselage is twice as broad as the conventional fuselage, but it is given an airfoil form and thereby contributes to the lift. At the same time the two engines are mounted inside the fuselage, at its leading edge. It is claimed for the Burnelli principle that the relatively enormous passenger space is obtained without any sacrifice of aerodynamic efficiency.

The Fokker Aircraft Corporation has also been working in the direction of the flying wing. A bomber recently tested has its cantilever wings of such thickness that the fuselage fits completely into the wing at the root. At the same time the two Curtiss Conqueror engines also merge completely into the thick wing.

In the Boeing mail plane, the Monomail, a retractable chassis is another method of reducing resistance. In discussing thick tapered wings, which provide such excellent spar depth to resist bending moments, it is often said that the drag of the thick wing must be greater than that of a thin wing with external bracing. We have the authority of R. J. Minshall of the Boeing Company for the statement that tapered wings are now available

which have an intrinsic profile drag no greater than that of the thin wing of the past.

Another aerodynamic development which is meeting with increasing favor is the Townend ring. This is a simple ring of a few inches in width, and of slight curvature along its width, which is made to surround the radial air-cooled engine. The Townend ring smooths out the flow when broken up by the projecting engine cylinders and enables the air to keep close and streamline contact with the fuselage. The Townend ring achieves the same purpose as the somewhat more complicated Venturi cowl, and is much simpler to build.

In those landing gears which are not retractable, designers are making efforts to reduce resistance by putting "pants" or "spats" over the wheels, or by using cantilever struts, just one strut to a wheel instead of the two or three struts previously employed. Some designers have tried fairings which enclose both struts and wheels. Another aerodynamic improvement consists in the use of fillets between wing and fuselage. Experiments at New York University have given an exact rule for the design of such fillets or fairings.

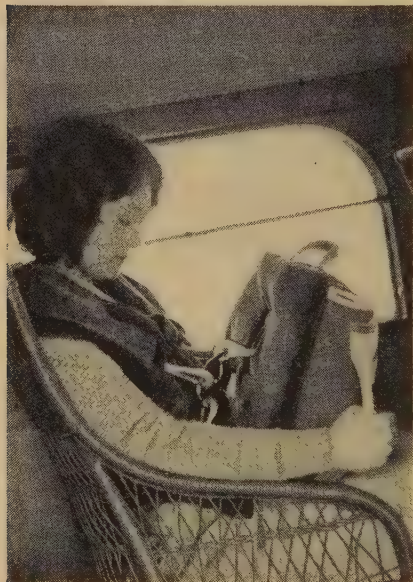
In general the airplane is rapidly approaching its ideal streamline form.

METAL COVERING FOR THE AIRPLANE

One of the most important problems engaging the attention of airplane designers today is that of metal covering instead of fabric covering for both the wings and fuselage of an airplane. Fabric covering has the disadvantage of poor maintenance and durability. Metal covering is unfortunately very heavy, even if the thinnest sheet is employed. Since the airplane is under very strict weight limitations, it is only desirable to use metal covering provided the covering itself contributes to the strength. Unfortunately thin metal sheet will not develop anything like its theoretical strength because of local failure termed "crinkling" when the sheet is in compression. The Navy Department and the Army Air Corps are both giving much attention to the problem of the metal covered fuselage, and in time disconnected efforts of various designers should lead to more accurate knowledge.

The large airplane of the future should

have a structure similar in some respects to the structure of the ocean liner, in which the metal plating is already so thick



INDIVIDUAL PARACHUTES WILL BE
STANDARD EQUIPMENT

that it can be confidently taken into account in the calculations of strength.

AIRCRAFT ENGINES

One of the most marked tendencies in the aircraft engine development for the year was the increasing number of inverted in-line air-cooled engines of the lower horse-power range which appeared. At both the St. Louis and the Detroit aircraft shows this type of engine was well represented.

Among the newer ones of this type we have the Chevolaire D-6, a six in-line, manufactured by the Chevolaire Motors, Inc. The engine is rated at 170 h.p. at 2000 r.p.m. Another of the interesting engines of the inverted type is the Hi-Drive Ensign engine manufactured by the American Cirrus Co. This is equipped with a DePalma super-charger and is rated at 110 h.p. at 2100 r.p.m.

The Fairchild Aviation Corporation

have also introduced an inverted six-in-line of 110 h.p.

Engines of this type (inverted-in-line) are somewhat heavier than radials of the same horse-power, but their greater simplicity, easier accessibility, better streamlining and vision qualities are making them more and more popular.

The Packard Diesel, over its first trial stages, is apparently finding acceptance among the aircraft designers and builders. Several transports, including Ford Trimotor and others, have offered planes using this engine.

The L-Head engine so popular in the automotive field, has lately entered aviation. The MacClatchie Manufacturing Company has placed a seven-cylinder radial L-Head engine on the market. The difficulty of cooling these L-Head air-cooled engines has apparently been overcome in this engine. It develops 150 h.p. at 1900 r.p.m. and weighs 400 lbs.

Another interesting development among the aviation engines is the increasing number of two-cycle engines that are making their appearance. Several small motors on this principle of about 30 horse-power designed for the light plane have been developed.

The 2-cycle engine undoubtedly has great possibilities in the aircraft field. This is especially true in regard to Diesels. The 2-cycle Diesel offers many advantages over the 4-cycle gas or oil engine or the present 2-cycle gasoline engine. The present 2-cycle design has four disadvantages: poor scavenging, delicate mixture control, low volumetric efficiency, poor fuel economy. The so-called "solid injection" of fuel would probably remedy this. The 4-cycle Diesel has the disadvantage of weight, high consumption of lubricating oil, and mechanical complications.

RECORD FLIGHTS

The year has witnessed remarkable record breaking performance. The refueling flight of the Army Plane "Question Mark" ushered in a contest to see which plane could stay aloft the longest. Notable among the many flights was that of the Hunter Brothers at Chicago who stayed up for 553 hours in a Stinson Detroiter.

Their record was broken by the former record holding team of O'Brien and Jackson who regained their title by staying in

the air some 743 hours in a Curtiss Robin plane. These flights proved beyond all doubt the feasibility of long, refueling flights.

Two other record breaking flights were made during the year. The first of these was that of Lieut. Apollo Soucek of the United States Navy who reached an altitude of 43,166 feet in a Wright Apache plane.

The Navy personnel had been experimenting for more than a year on improving the performance of the plane and no factor was overlooked which might raise the ceiling of the plane. When a study of the research data is complete the flight will assume a greater meaning to aviation.

The second flight was that of Capt. Hawks who put up a new trans-continental record in his 12 $\frac{1}{4}$ hour coast to coast flight. The flight was made in a Travelaire "Mystery S", the actual air time being 11 $\frac{1}{2}$ hours, $\frac{3}{4}$ of an hour being consumed in three refueling stops.

PRIVATE FLYING.

One of the reasons for the disappointing showing of the aviation industry this year is the slow growth of private flying. The reasons are easy to find. In spite of the results of the Guggenheim Safe Aircraft Competition, few manufacturers have sought to embody in their airplane designs the latest aerodynamic safety devices. Well informed opinion is that while be, they are still far from the ideal. Airplanes are much safer than they use to ports and fields are much more numerous than they used to be, but still far from being immediately accessible. A plane is expensive to purchase and expensive to maintain. All these obstacles will disappear, but they have not disappeared as yet. The position of the private plane owner is not at all that of the automobile owner but rather that of the motor boat owner a few years ago, who had to exercise skill, knowledge and determination to derive pleasure from his craft. A recent survey of the situation by *Aviation* gives a very fair picture of existing conditions. The typical private plane owner of today is a man in his early thirties, with an average income of about \$8000 a year. There is no typical occupation for the plane owner. He may be an advertising man, a junior

executive, a broker, publisher or salesman. He flies because he likes it. These men who purchase airplanes from a business point of view seem to find their investment a disappointing one. The average monthly flying time is only 13 hours and 24 minutes or about 160 hours a year. Flying is generally a matter of Saturday afternoons and Sundays. Some owners turn their craft over to professional pilots for passenger carrying work during the week in order to defray expenses. Crack-ups are fortunately few. The enthusiasts who fly for pleasure know their business as a rule and they are not under compulsion to fly in all weathers as air-mail pilots are for example. With this short flying time per year, and the rapid obsolescence of the modern plane, the question of "trade ins" will certainly bother the trade in the very near future. Owners find the maintenance of their craft quite onerous; it is always necessary to inspect control wires, gas lines, landing gear, etc. . . . and some 28.6 percent of the owners employ professional help. The most popular type of privately owned plane is the three-seater open cockpit machine, with an air-cooled engine of between 150 and 225 horse-power. It is expected that the cabin plane will take the place of a good many of the open cockpit machines, and manufacturers are anticipating this change in demand. In spite of the fascination of the flying boat and amphibian, few private owners purchase such craft. The drawback is in expense. It is gratifying to see that a few manufacturers are turning their attention to inexpensive amphibians. Aviation country clubs are a splendid social outlet, but the expenses of membership added to the flying expenses have checked the growth of this type of organization. The most promising line of attack would be the formation of flying clubs on the English model, clubs where inexpensive, low powered machines are employed, general expenses are restricted to essentials and no attempt is made to provide a luxurious social atmosphere. The many English flying clubs have of course been fostered by direct government subsidy. Another interesting view of the private plane owner is that flying is surrounded with too much mystery and too great a tendency to credit the pilot with super-man qualities.

AVIATION SAFETY

The present status of aviation safety is naturally a matter of considerable public interest. Perhaps the most authoritative statement on the subject yet issued, is the Report of Committee on Aviation Statistics of the Actuarial Society of America, which was compiled with the co-operation of many governmental and private agencies. It is impossible to present even in summary the findings of this report, which deals with every aspect of the subject. Perhaps the comparison with other modes of transportation will give the most graphic view of the situation. The Accident Bulletin of the Interstate Commerce Commission for the year 1928 shows a rate of .003 passengers killed per million railroad passenger miles. Only about one-fifth of these casualties took place in wrecks, but considering all of them the rate is approximately 1 death per 300,000,000 passenger miles. For the year 1929 there was a death rate among airway passengers of 1 death in 9000 flights. If an average trip of 300 miles is assumed, this develops into a rate of 1 death for each 2,700,000 passenger miles. The discrepancy in favor of the railroad is formidable, still it is not too formidable.

What is encouraging is that aviation, whether governmental, engineering, scientific or operational is fully aware of the importance of increasing safety. The methods of increasing safety are so numerous that they can only be presented in the briefest fashion. But perhaps the following remarks will give a picture of the energy and comprehensiveness of today's effort towards safety improvement.

The Guggenheim Safe Aircraft Competition produced a plane, the Tanager, equipped with the famous Handley Page slot, which was able to come to rest in 100 feet after touching the ground. The Tanager was also able to fly with power on at less than 35 miles per hour, with power off to glide at only 38 miles per hour. It also gave substantial evidence of being under perfect control in a variety of difficult circumstances.

The National Advisory Committee for Aeronautics has undertaken the systematic study of "spinning", that much dreaded cause of accidents and is evolving valuable data which should enable designers to build planes immune from such troubles.

The Aeronautics Branch of the Department of Commerce has inaugurated a system of licensing airlines, and of licensing only those airlines which are satisfactory in personnel, equipment and ground organization.

The perfection of radio communication between plane and airport, and the use of such communication by important airlines have arrived simultaneously with the provision of a nationwide weather service.

Instrument manufacturers are bestirring themselves to produce instruments which will give reliable indication to the pilot in fog flying. At the same time the technique of fog flying is better understood, and systematically imparted in the training of reserve pilots.

The Bureau of Standards has perfected its system of radio beacons, and is now experimenting with a system which will enable the pilot to land in fog with ease.

The insurance companies are inspecting planes and airlines and granting better rates to companies of more than usual status from the point of view of safety.

The Packard Diesel engine for aircraft, allowing the use of heavy fuel oil removes or diminishes the fire hazard.

The licensing of schools, and the licensing of transport pilots and ground mechanics are improving the status of the operating personnel.

Safety will come as a result of all such efforts, and their value is cumulative.

THE AVIATION INDUSTRY

The aviation industry is at present undergoing a period of severe depression. Many of the smaller airplane manufacturers are closing down, others are retrenching severely on personnel and cutting down on production, two of the biggest holding companies have issued reports showing enormous losses both absolutely and in percentage of invested capital.

Using a hackneyed phrase, the industry is nevertheless sound. The present difficulties are partially due to the general depression now ruling in the United States, partially to the wave of optimistic enthusiasm which swept over the aviation industry soon after Lindbergh's flight. The manufacturers overestimated the number of planes the public would buy. The schools overestimated the number of students likely to enroll. The companies



CURTIS "TANAGER" WON THE GUGGENHEIM SAFETY PRIZE

erecting airports overestimated the growth of student instruction and of private flying, and underestimated the effects of competition in the form of municipal airports. With this enthusiasm there followed a period of over-capitalization, with the public putting up far more money than the industry could profitably employ, so that at the present time the average return on aviation investment is negligible.

Yet the industry is growing rapidly all the time. It is only the rate of growth which has been misjudged.

Several favorable factors are already seen.

The Aeronautical Chamber of Commerce reports that the production of new planes is falling slightly behind sales, which indicates that inventories are being slowly liquidated. Severe price reductions which have recently come into effect will hasten this process of liquidation.

Another favorable feature lies in the export of American aircraft. The American industry is exporting an increasing portion of its production. In 1929 nearly 14 percent of its total production value was exported, mainly to Central and South America. At the same time there was a change in the character of the exports. War matériel and small training planes have been replaced, as far as exports go, by large transport planes, of far greater value. As a result of this change, the value of American aircraft exports has more than doubled in the last three years. Nor

have exports fallen off substantially during 1930, the worst of all years. For the first six months of 1930 they have totalled \$3,256,584 against \$3,589,196 in the first six months of 1929.

Again American air transport is growing rapidly and steadily. The merger of New York, Rio, Buenos Aires Airlines with Pan-American has resulted in the formation of the largest and most powerful air transport system in the world, which in a very few years will connect every important part in Central and South America with the United States. Pan-American is not only carrying vast quantities of mail, but with the use of large and reliable flying boats or amphibians it is transporting also a larger and larger number of passengers. In the United States progress in air transport is equally rapid.

The Aeronautical Chamber of Commerce reports that 133,000 passengers were carried by twenty-nine major transport lines in the first six months of 1929. The poundage of freight and mail was equally impressive, showing 137,398 pounds, with 82,165 pounds carried in the second quarter. The Watres bill, which will allow the Postmaster General to place contracts for mail on a space basis, and will permit the carrying of mail on passenger airplanes will serve to stimulate the growth of air transport still further.

There is not the slightest doubt that aviation will rapidly work out of the slump and in a few years assume gigantic proportions.—*Alexander Klemm, Aeronautical Editor Scientific American.*

INDIAN "BOW AND ARROW LORE"

USEFUL FOR MODERN ARCHERY

The twentieth century's revival of archery as a sport has led makers of equipment to turn to the American Indian for information. So skillful was the Indian with bow and arrow, both in warfare and in the hunt, that the fabricators of archery's implements, no doubt, would gladly sit beside the wigwam to get a few pointers. But the race of Indian bowmakers and arrowmakers has followed the Buffalo to the happy hunting ground. The lore that has lived after them is available still, however, and some of it is to be found in a recent Smithsonian Institution publication.

The Osage and the Kansa tribes are held to have had the best bows—not that their workmanship was superior but because they managed to get hold of the most suitable wood. The Osage and the Kansa called it smooth bow, the Omaha knew it as yellowwood, the French voyageurs as bois d'arc. It was procured along the Arkansas River. It did not grow well north of Kansas, and where it was not available, ash, white elm, or ironwood was used, because they would take on a polish and would not warp badly when exposed to wet weather. The general preference was for young ash killed by a prairie fire, because then it was sure to be well seasoned.

The wood for the arrow was selected with equal care and handled with equal patience. Experience had taught that the more serviceable were the ash and a species of dogwood, known to the Omaha, Ponce, Osage and Kaw as arrowwood. Of the latter, saplings were preferred on account of their straightness and freedom from knots. Mature ash, on the other hand, was taken, the sapling being too pithy and soft. Both woods can be polished and are flexible. When neither ash nor dogwood was obtainable, wild cherry was used, but only in emergency, since this wood breaks easily. The shafts were cut the desired length and roughly shaped, then tied in a bunch and hung over the fireplace to season.

The Indian's bowstring was made from the sinew lying on either side of the buf-

falo's spine. The making of the bowstring was a task apart, performed by a specialist. The bowstring maker would take five sinews, soak them in glue water over night and in the morning squeeze them as dry as he could and splice together the ends, making one long strand. This, when partially dried, he looped in the middle, and put the loop over the end of a small pole planted in the ground. With an end of the strand in each hand he twisted them until they were rolled firmly into one. Then he knotted the finished cord.

After the arrow shafts had hung by the fire ten days or two weeks, the arrowmaker examined them for crooked places, greased these spots and heated them over the fire, then quickly straightened them and held them so until they had cooled. The straightening implement was a deer's horn through which a hole had been drilled. Between sandstone polishers, held against his thigh, he twirled the shaft until it was round, smooth and uniform, then he notched it for the bowstring.

Every arrow was provided with three zigzag grooves, usually put in by another specialist. Some writers have said these were to symbolize lightning; others that they were a channel for the blood of the wounded animal; but the explanation given by one aged Omaha arrowmaker was that the groove kept the straightened wood straight, correcting any tendency to roll back to its natural crookedness.

Owl feathers were popular for feathering the shaft. These were taken from the wings, the stems split and the pithy part scraped clean with a knife; then they were bound in place with sinew, and glue possibly made from the shell of a soft-shelled turtle. A pile of white powder, made of burnt gypsum, was used for cleaning, whitening and drying the sinew, the combined function of which was to hold the ends of the feathers on the shaft and prevent the notch from being split by the bowstring. The web of each feather was trimmed, to hold the arrow steady on its course. Finally, the shaft was decorated with markings according to the order of the arrowmaker's customer.—N. Y. Times.

In contradiction to the popular belief that, though primitive peoples lacked training in the arts of civilization, they were experts in the manufacture of bows and arrows, the University of California Press has just published a book by the late Dr. Saxton Temple Pope indicating that even in this field the aborigine was inferior to civilized man.

The book, titled "A Study of Bows and Arrows," represents the results of comparative tests of the efficiency of dozens of types of bows and arrows from the University of California Museum of Anthropology, the American Museum of Natural History and from private collections. Dr. Pope died in 1926.

One particular experiment of which Dr. Pope tells had to do with a bow from Paraguay, South America, at the university museum. It was a heavy, crooked bow, apparently of ironwood, seventy-one inches long, drawing twenty-five inches and weighing or pulling sixty pounds on the

string. It cast an arrow 170 yards. Just to see what intelligence could do to improve this primitive bow, Dr. Pope altered it. He says:

"By heating the wood the lateral deviations were straightened. The wood was planed off the limbs so that a gradual taper was attained, and the bend was distributed throughout the limb instead of being limited to the extreme ends. Its length was reduced to five feet seven inches, horn nocks of the English type were put on and a linen string applied. The altered weapon became an excellent bow, bending with a fine symmetrical curve, quick in its action and very powerful. As it stands now, when drawn twenty-eight inches the bow pulls eighty-five pounds instead of sixty, and casts an Ishi flight arrow 265 yards. With a specially made bamboo arrow this was increased to 275 yards. This demonstrates what intelligence can do in the bowyers' art."—*N. Y. Herald Tribune*.

GOLDBEATER SKINS FOR AIRSHIPS

For retaining the precious hydrogen or helium lifting gas in Zeppelin airships,



ALL HANDWORK ON GOLDBEATER SKINS

nothing has been found superior to goldbeater skins. This extremely tough substance forms the outer covering of a por-

tion of a steer's intestinal system. For centuries it has been used for holding gold sheets while they were being hammered into thin foil. Hence the name.

The skins are shipped in their raw state from the packing house to the airship cell manufacturer in barrels, each containing about 2500 pieces. After skins arrive at the factory, they are scraped with knives until all particles of adhering flesh and other matter are removed. This cleaning takes place after the skins have been softened by soaking in water. They are then inspected for flaws. Irregular edges are trimmed off and weak places removed. This often reduces the size of the skin considerably. When finished, the shape is rectangular.

The rectangular skin is then spread on rubberized balloon cloth, previously coated with rubber cement, the edges of the pieces overlapping about 1½ inches. This operation completes the manufacture of the gas-cell fabric.

Rubberized fabric has been used also for the making of gas cells, but, in general, has not been found as impervious to lifting gas as goldbeater skin. Recent developments promise to make available a material that will replace the expensive skincoated cloth.

TANTALUM

RARER THAN GOLD

Tantalum is a rare element—so rare in fact that estimates indicate there is less tantalum than gold in the earth's crust. Next to tungsten, tantalum has the highest melting point and the lowest vapor pressure of all metallic elements. It is so unusually resistant to chemical corrosion that many acids that attack other metals do not affect it. Tantalum when heated above 350° will take up 740 times its own volume of hydrogen.

After remaining a laboratory curiosity for many years, tantalum was used to a limited extent and for relatively few years for incandescent electric-light-bulb filaments, says E. P. Youngman, in a report on tantalum and columbium just published by the Bureau of Mines. Interest in tantalum was again aroused when its electrolytic-valve action was discovered and taken advantage of in charging storage batteries, especially for radio work. Tantalum chargers were eventually displaced by other types of chargers, but for a time they were manufactured in sufficiently large numbers to create a demand large enough to bring about its production on a commercial scale in the United States. As tantalum became available in larger quantities and at substantially lower prices, and as high prices for platinum encouraged the employment of tantalum as a substitute, the metal was put to many new uses. Ferrotantalum was made and sold before the World War, and patents have been taken out for a number of special alloys for industrial purposes.

The rapid increase in production reflects the increasing use to which tantalum is being put.

Commercial tantalum has a purity of at least 99.5 per cent. It is a platinum-white metal when polished, though it often has a steel-blue color, owing probably to a thin film, on the unpolished surface. Its tensile strength is two and one-half times that of hard platinum, and it can easily be made as hard as iridioplatinum. When tantalum is used cold, it appears that platinum alone has properties that rival it.

The most characteristic chemical property of tantalum is its unusual resistance

to chemical corrosion. It is not attacked by hydrochloric or nitric acid or by aqua regia, either hot or cold. Dilute sulphuric acid does not attack it at ordinary or more elevated temperatures, but boiling concentrated sulphuric acid does appear to have some action upon it. Tantalum also is attacked with difficulty by solutions of caustic alkalies. In fact, hydrofluoric acid seems to be the only chemical agent that will attack it.

Tantalum can be worked cold, drawn, hammered, machined, polished, hardened, rolled, and punched. The pure metal is rather easily worked. The forms in which the metal may be readily obtained include wire from .001 inch in diameter up to heavy bar, sheet from .002 inch in thickness to varying widths, and tubing of various sizes.

Probably the largest use of tantalum now is in connection with the manufacture of radio and power tubes. Increasing quantities are being used in the manufacture of certain alloys, in the manufacture of spinners employed in the making of rayon, in the lining of chemical equipment, and in jewelry.

With respect to further extension of the use of the metal, the chief problem is to ascertain to what extent it can replace platinum in the laboratory and factory and for acid-resisting equipment. It has not been proved that tantalum will provide a cheaper substitute for platinum in these connections. For precision weights, however, it is recognized internationally as a substitute for platinum. In electrical appliances tantalum offers possibly a better service. Although, among the noble metals platinum alone is a strong rival, tantalum is limited in usefulness chiefly by the fact that it cannot be raised above the temperature of about 350° without absorbing gases and without undergoing deterioration; when it is used hot it must be in a high vacuum.

Many alloys of tantalum have been described, though few have entered industry. The alloys may be conveniently grouped in three classes, as follows:

The alloys of high melting point con-

tain from 1 to 40 per cent tantalum, combined with different proportions of molybdenum, tungsten, carbon manganese, nickel, vanadium, and silicon. Tantalum, it is claimed, may replace all or part of the tungsten or the molybdenum.

The hard alloys, containing as much as 50 per cent of tantalum, combined with iron, chromium, vanadium, tungsten, molybdenum, or carbon, are employed in the manufacture of tools. Ferrotantalum-columbium (niobium) has been produced for many years for use especially in high-speed steel.

The amount of tantalum used in acid-resisting alloys seems to be rather small. Since the introduction of the first rustless steel (an alloy of tantalum and iron), other alloys have been developed that have caused keen competition. Recently, alloys of tantalum with iron and aluminum have come into existence.

Tantalum and columbium (or niobium), almost invariably found together, occur in a large variety of minerals, none of which, however, are very widely distributed. Tantalite, skogbolite and tapiolite (tantalates of iron and manganese), and micro-lite (a calcium tantalate) are the richest in tantalum. Tantalite, or columbotantalite, is the principal commercial source of the metal.

Since at the present time columbian, having no commercial importance, only increases the cost of tantalum, a grade of tantalite containing at least 60 per cent of tantalum oxide and only a few per cent of columbium is generally used.

Simpler methods of extraction would bring about a greater use of tantalum and would probably introduce columbium to industry.

Tantalum minerals, though known to exist in many mineralized localities throughout the world, are produced in commercial quantities in but a very few—Western Australia ranking first, followed by South Dakota (United States). There

is enough interest in the tantalum deposits in Northern Australia, in Rhodesia, and in Southwest Africa (a mandate of the Union of South Africa) to justify the expectation that these countries will soon produce small quantities at least; and a property in Northern Australia, recently optioned, is reported to contain one of the largest known deposits of tantalite in the world.

A Chicago concern, which in 1922 began the production of metal in sheets and rods large enough to be employed in pen points, dental instruments, chemical apparatus, and like equipment, is the only firm in the United States that is manufacturing the metal.

A little columbite was produced in the United States as early as 1904 and shipped abroad; there was a smaller production in 1905; in 1906 a commercial production was reported from Colorado and South Dakota, which went to Germany, and a few pounds were reported from North Carolina; in 1907 a small production of unknown weight and value, probably from South Dakota and North Carolina, was shipped to France; in 1908 no output was reported; in 1909, 1910, and 1911 small quantities were reported as mined but not as marketed; and from 1912 to 1918 there was no production reported.

Without adequate import and export figures, it is difficult even to suggest probabilities for the future tantalum market or to interpret the past at all accurately. It is known that most of the domestic production has been shipped to England and Germany and that quantities of Australian ore, which is of a higher grade than the American ore, are shipped to the United States. In 1922 there was a definite increase in home production and in 1928 production was 34 times that of 1927. It was in 1922 that the manufacture of electrolytic rectifiers, in which tantalum was used, began; and it was in 1927 that a company at Malvern, Pa., began making use of tantalum in laboratory equipment.

GREAT NOVELS

Prof. W. H. F. Lamonts—60

- *FIELDING—"Tom Jones," 1749.
- *GOETHE—"Wilhelm Meister's Apprenticeship," 1796.
- *AUSTEN—"Pride and Prejudice," 1813.
- †SCOTT—"Guy Mannering," 1815.
- †"Heart of Midlothian," 1818.
- *COOPER—"Last of the Mohicans," 1826.
- MANZONI—"The Betrothed," 1826.
- *HUGO—"Notre Dame," 1830.
- *"Les Misérables," 1862.
- *BALZAC—"Père Goriot," 1834.
- †"Cousine Bette," 1846.
- BEYLE—"Rouge et Noir," 1830.
- *DUMAS—"Three Musketeers," 1844.
- BRONTE—"Jane Eyre," 1847.
- *BRONTE—"Wuthering Heights," 1847.
- *THACKERAY—"Vanity Fair," 1848.
- *"Henry Esmond," 1852.
- *DICKENS—"David Copperfield," 1850.
- *"Great Expectations," 1861.
- *HAWTHORNE—"Scarlet Letter," 1850.
- *MELVILLE—"Moby Dick," 1851.
- FREYTAG—"Debit and Credit," 1855.
- *FLAUBERT—"Madame Bovary," 1856.
- "Salambo," 1864.
- *ELIOT—"Adam Bede," 1859.
- READE—"Cloister and Hearth," 1861.
- *TURGENEV—"Fathers and Sons," 1861.
- †"Jurgin Soil," 1876.
- *DOSTOIEVSKY—"Crime and Punishment," 1866.
- **"Brothers Karamazov," 1880.
- *TOLSTOY—"War and Peace," 1869.
- **"Anna Karenina," 1876.
- *JAMES—"The American," 1877.
- *HARDY—"Return of the Native," 1878.
- **"Tess of the d'Urbervilles," 1891.
- †MEREDITH—"The Egoist," 1879.
- †ZOLA—"Nana," 1880.
- *FRANCE—"Crime of Sylvestre Bonnard," 1881.
- *TWIN—"Huckleberry Finn," 1884.
- †HOWELLS—"Rise of Silas Lapham," 1884.
- *SUDERMANN—"Dame Care," 1888.
- VERGA—"House by the Medlar Tree," 1890.
- LAGERLOF—"Gosta Berling's Saga," 1894.
- MANN—"Buddenbrooks," 1901.
- *ROLLAND—"Jean Christophe," Vol. I, 1904.
- †CONRAD—"Nostromo," 1904.
- †WHARTON—"House of Mirth," 1905.
- *BENNETT—"Old Wives' Tale," 1908.
- DREISER—"Jennie Gerhardt," 1911.
- PROUST—"Swann's Way," 1913.
- LAWRENCE—"Sons and Lovers," 1913.
- MAUGHAM—"Of Human Bondage," 1915.
- NEXO—"Pelle the Conqueror," 1916.
- CABELL—"Jurgin," 1919.
- WASSERMANN—"World's Illusion," 1920.
- *HAMSUN—"Growth of the Soil," 1920.
- UNSET—"The Bridal Wreath," 1920.
- *GALSWORTHY—"The Forsyte Saga," 1922.
- GLASGOW—"Barren Ground," 1925.
- ZWEIG—"Case of Sergeant Grischa," 1928.

—N. Y. Times.

*Shows entire agreement on 33.

†Shows substantial agreement on 9 additional authors. A total of 42 out of 60. Prof. Phelps' list includes titles that will live for Americans, such as Robinson Crusoe, Gulliver's Travels, Uncle Tom's Cabin, Alice in Wonderland, Treasure Island, Kim, The Call of the Wild, etc.

Prof. William Lyon Phelps—100

- DEFOE—"Robinson Crusoe."
- SWIFT—"Gulliver's Travels."
- RICHARDSON—"Pamela"; "Clarissa."
- *FIELDING—"Joseph Andrews"; "Tom Jones."
- SMOLLETT—"Humphry Clinker."
- PREVOST—"Manon Lescaut."
- GOLDSMITH—"The Vicar of Wakefield."
- *GOETHE—"Wilhelm Meister"; "Electric Affinities."
- *AUSTEN—"Pride and Prejudice"; "Emma"; "Persuasion."
- †SCOTT—"Ivanhoe"; "The Bride of Lammermoor"; "Quentin Durward."
- *COOPER—"Last of the Mohicans"; "The Pilot."
- *HUGO—"Notre Dame"; "Les Misérables."
- *DUMAS—"The Three Musketeers"; "Twenty Year After"; "The Vicomte de Bragelonne"; "Monte Cristo."
- †BALZAC—"Eugenie Grandet"; "Le Père Goriot."
- *FLAUBERT—"Madame Bovary."
- *DICKENS—"Pickwick Papers"; "David Copperfield"; "The Old Curiosity Shop"; "Great Expectations"; "Our Mutual Friend."
- *EMILY BRONTE—"Wuthering Heights."
- *THACKERAY—"Vanity Fair"; "Henry Esmond."
- *HAWTHORNE—"The Scarlet Letter"; "The House of the Seven Gables."
- *MELVILLE—"Moby Dick."
- STOWE—"Uncle Tom's Cabin."
- *ELIOT—"Adam Bede"; "Mill on the Floss."
- READE—"The Cloister and the Hearth."
- BJORNSEN—"Synnove Solbakken"; "In God's Way."
- GOGOL—"Taras Bulba."
- *TURGENEV—"A House of Gentlefolk"; "Father and Children"; "On the Eve"; "Smoke."
- *TOLSTOY—"War and Peace"; "Anna Karenina"; "The Death of Ivan Ilyitch"; "Resurrection."
- *DOSTOIEVSKY—"Memoirs of the House of the Dead"; "Crime and Punishment"; "The Idiot"; "The Brothers Karamazov."
- CARROLL—"Alice in Wonderland."
- HUDSON—"Green Mansions."
- TROLLOPE—"Barchester Towers."
- COLLINS—"The Moonstone."
- *JAMES—"The American"; "Portrait of a Lady."
- BLACKMORE—"Lorna Doone."
- †MEREDITH—"The Ordeal of Richard Feverel."
- †HOWELLS—"A Modern Instance."
- *HARDY—"The Return of the Native"; "The Woodlanders"; "Tess of the d'Urbervilles."
- *TWIN—"Tom Sawyer"; "Huckleberry Finn."
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 *BENNETT—"The Old Wives' Tale."
 *HAMSUN—"Growth of the Soil."
 †WHARTON—"The Age of Innocence."
 LEWIS—"Dodsworth."
 WILDER—"The Bridge of San Luis Rey."
 —N. Y. *Herald Tribune*.

RADIO'S DEBT

Absorbed in the recent development of radio, the public is prone to overlook its indebtedness to the hundreds of inventors who, working over a period of centuries, have made radio possible, declares Clarence A. O'Brien, well known patent attorney and authority on basic inventions.

The average receiving set, for example, contains thousands of feet of copper wire, —11,000 feet of fine wire in an Atwater Kent speaker alone. The invention of drawing wire is ascribed to Rodolph of Nuremberg, about 1410, while mills for this purpose were set up in Nuremberg in 1563. Prior to that time wire was hammered out—wholly inadequate for the niceties of radio where the wire is frequently finer than human hair.

As a reminder of the radio audience's obligation to the inventors of the telephone—Alexander Graham Bell in 1875, Edison, Gray, Blake and others, the National Broadcasting Company in its national network relies on from 35,000 to 50,000 miles of telephone wire. The microphone, as essential to radio as to the telephone, was invented by Emil Berliner.

Marconi's development of radio has tended to eclipse the work of James Clerk Maxwell, the great British physicist who in 1865 first promulgated the theory fundamental to radio, demonstrated by the German scientist Heinrich Hertz in 1887, long before Marconi made his contribution. The U. S. Patent Office lists in the past few years the names of numerous inventors

without whose work radio would not have reached its present perfection.

Had Maxwell perfected a radio back in 1865, radio broadcasting as now known would then have been impossible. There was no telephone or network of telephone wires. Dynamos had not been developed to the necessary efficiency, while the possibility of electrical transmission of power came later.

The progress of electrical development, so essential to radio, must be traced through hundreds of names—Michael Faraday, who discovered the principle of the dynamo in 1831; James Watt; James P. Joule; Sir William Watson; Charles A. Coulomb; Andre M. Ampere; G. S. Ohm; Carl F. Gauss, and many others in addition to the long list of American contributors to electrical research, since Benjamin Franklin's day.

As far back as 321 B. C., the ancient philosopher Theophrastus mentions the power of amber to attract straws and dry leaves. Pliny, in 70 A. D., writes concerning the same phenomenon, and it is from "electron," the Greek name for "amber," that we call this phenomenon "electricity."

The radio tube is a vacuum, and Evangelista Torricelli, Italian physicist, first discovered the vacuum in his experiments on the barometer, at Florence, in 1643. The first primary battery was constructed in 1799 by Alessandro Volta, and developed by Daniell, Meidinger and others, following the Leyden jar of 1745.

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